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Psychometric Properties Of The Coping Inventory For Stressful Situations In Individuals With Traumatic Brain Injury

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PSYCHOMETRIC PROPERTIES OF THE COPING INVENTORY FOR STRESSFUL SITUATIONS IN INDIVIDUALS WITH TRAUMATIC BRAIN INJURY

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TABLE OF CONTENTS

Acknowledgements ii

List of Tables iv

List of Figures v

Chapter 1 – Introduction 1

Chapter 2 – Method 18

Chapter 3 – Results 23

Chapter 4 – Discussion 73

Appendix A –Tables 1 – 11 89

Appendix B – Figures 1 – 14 100

Appendix C – HIC Approval 114

References 115

Abstract 126

Autobiographical Statement 128

LIST OF TABLES

Table 1. Demographic, Injury-related, and Psychosocial Characteristics of Participants with Traumatic Brain Injury (*N* = 331).....89

Table 2. Coping Inventory for Stressful Situations: Descriptives and Alpha Reliabilities among Participants with TBI at 1, 2, 5, 10 or 15 Years Post Injury.....90

Table 3. Coping Inventory for Stressful Situations (CISS) Descriptive Statistics and Alpha Reliabilities among Participants with No, Mild, Partial, and Moderate-Severe Disability 91

Table 4. Descriptive Correlations: Coping Style, Well-being, and Demographic Characteristics (*N* = 331).....92

Table 5. Hierarchical multiple regression predicting disability at follow up (DRS).....93

Table 6. Hierarchical multiple regression predicting satisfaction with life at follow up (SWLS) 94

Table 7. Fit Mean-square Statistics for CISS All Items.....95

Table 8. Fit Mean-square Statistics for CISS Task scale.....96

Table 9. Fit Mean-square Statistics for CISS Emotion scale.....97

Table 10. Fit Mean-square Statistics for CISS Avoidance scale 98

Table 11. Select diagnostic data for Rasch analysis with CISS.....99

LIST OF FIGURES

Figure 1. Coping Inventory for Stressful Situations (CISS) Scales by Disability Rating Scale (DRS) group (No, Mild, Partial, and Moderate-Severe Disability). 100

Figure 2. Item-Person Map: Chronic, All Items 101

Figure 3. Response Category Thresholds: Chronic, All Items 102

Figure 4. Item-Person Map: Chronic, Task 103

Figure 5. Item-Person Map: Chronic, Emotion 104

Figure 6. Item-Person Map: Chronic, Avoidance 105

Figure 7. Item-Person Map: Year 1, All Items 106

Figure 8. Item-Person Map: Year 1, Task 107

Figure 9. Item-Person Map: Year 1, Emotion 108

Figure 10. Item-Person Map: Year 1, Avoidance 109

Figure 11. Item-Person Map: Year 2, All Items 110

Figure 12. Item-Person Map: Year 2, Task 111

Figure 13. Item-Person Map: Year 2, Emotion 112

Figure 14. Item-Person Map: Year 2, Avoidance 113

CHAPTER 1

INTRODUCTION

Traumatic brain injury (TBI) is a prevalent and growing public health concern in the United States, affecting 1.7 million individuals on average each year (Faul, Xu, Wald, & Coronado, 2010). TBI is an "injury to brain tissue caused by an external mechanical force as evidenced by loss of consciousness from brain trauma, posttraumatic amnesia, skull fracture, or objective neurological findings that can be reasonably attributed to TBI by physical or mental status examination" (Dahmer, Shilling, & Hamilton, 1993). Of those who sustain a TBI each year in the United States, 1.4 million individuals are treated and released by an emergency department; of the remaining individuals with TBI, 275,000 are hospitalized and 52,000 die (Faul et al., 2010). Over the last decade, the numbers of individuals with TBI who are treated by emergency departments or who are hospitalized have significantly increased; in relation to total injury-related deaths each year in the United States, TBI plays a role in about one third of these mortalities (Faul et al., 2010). Furthermore, recent estimates suggest that approximately 124,000, or 43%, of individuals hospitalized each year for a TBI develop lasting related disabilities by 1 year post injury (Selassie et al., 2008), and approximately 3.2 million Americans currently live with lasting disabilities consequence of a TBI (Zaloshnja, Miller, Langlois, & Selassie, 2008). These figures attest to the scope of TBI and its long-term impact on individuals, and given the high rate of unaccounted or untreated TBI in civilian and military populations, these figures actually underrepresent the prevalence and severity of TBI in the United States (Corrigan, Selassie, & Orman, 2010).

TBI is associated with impairments in a wide range of contexts, including physical, cognitive, emotional, and social functioning. For persons with moderate to severe TBI, Dikmen and colleagues' (2009) review found that a significant subset of individuals experience long-term

cognitive deficits, defined as impairment persisting at least 6 months post injury. For example, Lannoo et al. (1998) compared persons with moderate to severe TBI to matched trauma controls at 6 months post injury and found that the TBI group demonstrated significantly greater cognitive impairments on tests of attention, information processing, reaction time, memory and learning, verbal fluency, and mental flexibility. Similarly, Tate et al. (1991) compared persons with severe TBI to matched sibling controls at 6 years post injury and found that 70% of the TBI group had significant cognitive impairments, which were significantly worse than the control group in all cognitive areas assessed. In studies comparing persons with all severities of TBI to non-injured or trauma matched controls, results of cognitive testing at 1 year post injury suggest that persons with TBI have greater cognitive impairments compared to controls and that persons with more severe TBI perform worse on testing than those with less severe brain injuries (Dikmen et al., 2009).

Whether a direct neurological consequence of TBI or an indirect result of other psychological factors, psychiatric disorders represent a major area of impairment following TBI and may slow the recovery process (Hesdorffer, Rauch, & Tamminga, 2009; Rogers & Read, 2007). Hesdorffer and colleagues' (2009) review found that persons with TBI at 6 months post injury or longer experience elevated levels of depression, aggressive behavior, and psychosis, in cases of moderate or severe TBI, as compared to controls. Mood disorders, such as depression, are found commonly among civilian and military persons with TBI (Hesdorffer et al., 2009) and a significant proportion of persons with TBI experience symptoms of depression even several years post injury (Curran, Ponsford, & Crowe, 2000). For example, Jorge and colleagues (2004) compared persons with TBI to trauma controls at 1 year post injury and found that persons with TBI had significantly greater levels of mood disorders; they also found that depression was more common among persons with TBI who had prior anxiety or who had concurrent anxiety or

aggression. Although depression is common following TBI regardless of premorbid depression status, a history of this disorder does increase an individual's risk of developing depression post injury (Fann et al., 2004; Jorge et al., 2004).

Furthermore, persons with TBI often experience difficulties with social functioning, which may relate in part to impairments in emotional or behavioral, cognitive, and physical functioning. In studies comparing persons with TBI to trauma controls, the TBI groups generally show poorer functional outcomes and poorer psychosocial functioning (Temkin, Corrigan, Dikmen, & Machamer, 2009). Similarly, persons with TBI typically have lower rates of return to work as compared to trauma control groups, or they take longer to return to work, with worse outcomes associated with increasing injury severity (Temkin et al., 2009). As might be expected, those with TBI also have decreased independence post injury as compared to trauma controls, with rates of returning to independent living adversely associated with injury severity (Temkin et al., 2009).

In addition to the acquired impairments associated with TBI, persons with TBI show increased distress and diminished life satisfaction (Corrigan, Bogner, Mysiw, Clinchot, & Fugate, 2001). In the aftermath of TBI, patients often have increased mental health concerns, such as depression and anxiety. These patients also show a wider range of psychological disturbances following TBI. For example, at 1 year post injury, persons with TBI showed poor emotional and behavioral adjustment, such as increased anxiety, anger and impulsivity, confusion, helplessness, and suspiciousness of others, as compared to a normative sample (Hanks, Temkin, Machamer, & Dikmen, 1999). However, recovery patterns differ across these domains, such that TBI patients often improve in areas relating to cognition, mental status, and emotional stability and deteriorate in areas relating to anger and impulsivity, antisocial behaviors, and self-monitoring (Hanks et al., 1999).

Generally, individuals with TBI have diminished levels of life satisfaction. Life satisfaction reflects a person's broad assessment of their life, ranging from positive to negative, rather than a reflection of an isolated feeling or specific area of life (Burleigh, Farber, & Gillard, 1998). Life satisfaction has been described as an element of subjective well-being, in conjunction with happiness and morale, and these terms are often used interchangeably (Fuhrer, 1994). Several factors contribute to life satisfaction following TBI, including psychosocial variables, such as depressed mood, employment status, and marital status, premorbid characteristics such as substance abuse history, and injury characteristics such as motor independence upon leaving rehabilitation (Corrigan et al., 2001). In addition, when impairments lead to disability and handicap in the social and productive areas of functioning, persons with TBI experience decreased life satisfaction (Heinemann & Whiteneck, 1995). Similarly, Burleigh and colleagues (1998) found that in the aftermath of TBI, the social aspect of community integration, rather than total community integration including social, home, and productivity domains, significantly relates to life satisfaction.

Coping after TBI. Taken together, these findings clearly indicate that many people struggle to cope with the stress of living with a TBI and the subsequent impairments to their functioning. Increased distress likely plays a major role in the increased levels of emotional disturbances, cognitive and behavior problems, and substance use, as well as declines in social functioning and overall life satisfaction seen in this population. To provide optimal care, target treatment, and enhance outcomes for individuals with TBI, it is important to expand our understanding of factors that influence the recovery process. In addition to severity of injury (Dawson, Levine, Schwartz, & Stuss, 2004), several factors affect the recovery process following TBI, including psychological functioning (Dawson, Schwartz, Winocur, & Stuss, 2007). In particular, coping style is an aspect

of psychological functioning that might influence response to and recovery from TBI (Anson & Ponsford, 2006a; Curran et al., 2000; Dawson et al., 2007). Unfortunately, despite the well-documented magnitude of this problem, research examining successful and unsuccessful mechanisms of coping with the stress of TBI is sparse.

Coping and coping styles. All individuals when faced with stressful or negative situations engage in coping responses aimed to alleviate their anxiety or stress. Endler, Parker, and Summerfeldt (1993) describe coping as "an individual's cognitive, affective, and behavioural attempts to reconcile a perceived discrepancy between situational demands and personal capacity or competence." Although historically coping was conceptualized as unconscious defense mechanisms, the current model of coping emphasizes the role of conscious processes or behaviors in response to external stressful situations (Endler & Parker, 1990). For example, Folkman and Lazarus (1985) propose a process-oriented approach in which coping occurs in response to environmental and psychological pressures associated with stressors.

When stressed, individuals implement different coping styles or strategies. Many researchers have tried to delineate the various components of coping and to examine the potential benefits of one coping style over another. The research suggests that individuals utilize similar coping responses across various stressful events, allowing researchers to classify individuals by their predominant coping style (Endler & Parker, 1990). Although there are numerous theories and proposed components of coping, a predominant distinction is made in this literature between problem-focused coping and emotion-focused coping (Skinner, Edge, Altman, & Sherwood, 2003). Consistent with this distinction, Folkman and Lazarus (1985) describe coping as having two main functions, "the regulation of distressing emotions [emotion-focused coping] and doing something to change for the better the problem causing the distress [problem-focused coping]"

(Endler & Parker, 1990). Endler and Parker (1990) further described emotion-focused coping as reflecting "person orientation" and problem-focused coping as reflecting "task-orientation." Additionally, they proposed a third style of coping in which individuals avoid stressful situations by seeking social support, a person orientation, or by seeking distracting activities, a task orientation (Endler & Parker, 1990). Based on their work, a prevalent theory on coping suggests a three-factor structure of coping style: task-oriented, emotion-focused, and avoidant (Endler & Parker, 1990, 1994).

Extensive research supports the role of coping as a mediator between stressful situations and psychological and physical functioning (Endler & Parker, 1990). Within a health psychology framework, Sachs (1991) described the importance of coping in relation to health and illness, "failure to cope well with stress can enhance illness… adequate coping reflects psychological strength that promotes health." Similarly, within a diathesis-stress framework, Taylor (1990) described the role of coping in moderating the relationship between diatheses for illness, or physiological risk factors, and environmental stressors.

Coping in medical and rehabilitation populations. Coping style has been shown to be an important factor relating to functioning in patients with physical disorders. In general, coping style has been associated with adjustment to chronic medical illness (Bombardier, D'Amico, & Jordan, 1990), such as chronic pain (Cui, Matsushima, Aso, Masuda, & Makita, 2009), chronic digestive disorders (Calsbeek, Rijken, Bekkers, Van Berge Henegouwen, & Dekker, 2006), and diabetes (Macrodimitris & Endler, 2001). Coping style also influences outcomes following rehabilitation for physical injury, such as serious musculoskeletal injury in motor vehicle accidents (P. A. Hall, Marshall, Mercado, & Tkachuk, 2011), traumatic physical injury (i.e., orthopedic trauma, burn (Victorson, Farmer, Burnette, Ouellette, & Barocas, 2005), and spinal cord injury (Hanson,

Buckelew, Hewett, & O'Neal, 1993). Among persons with Parkinson's disease, adults who did not employ task-oriented coping strategies had increased risk of depression, anxiety, and poor health-related quality of life (Hurt et al., 2012).

Furthermore, coping style has been shown to be an important factor relating to functioning in patients with psychological disorders, such as depression (McWilliams, Cox, & Enns, 2003), substance use (Courbasson, Endler, & Kocovski, 2022) and panic attacks (Cox, Endler, Swinson, & Norton, 1992). In rehabilitation following TBI and serious orthopedic injury, coping style plays a unique role in understanding level of depression and anxiety, even after accounting for age at injury, injury type, and handicap (Curran et al., 2000).

Specific coping styles and well-being. Across the literature, avoidant and emotion-focused coping styles are associated with relatively poorer functioning than task-oriented coping style (Cosway, Endler, Sadler, & Deary, 2000; Endler & Parker, 1994; Endler et al., 1993). Specifically, coping style characterized predominately by an emotional, non-productive focus is directly associated with depression and anxiety, whereas coping style characterized predominately by a problem focus is inversely associated with depression and anxiety (Bombardier et al., 1990; Cohan, Jang, & Stein, 2006; Curran et al., 2000). In rehabilitation outcome studies, patients with more active versus passive coping styles experience improvements in quality of life and physical functioning following motor vehicle accidents (P. A. Hall et al., 2011), have greater acceptance of disability following spinal cord injury (Hanson et al., 1993), and have greater positive affect, self-esteem, and less psychopathology following TBI (Anson & Ponsford, 2006a). Similarly, reliance on behavioral disengagement, emotional venting, and self-blame coping strategies are associated with increased distress post injury in trauma and burn patients (Victorson et al., 2005).

Of note, coping style has been shown to change during rehabilitation among cognitively normal patients (Ninot et al., 2006). For example, patients with chronic obstructive pulmonary disease (COPD) showed increase in problem-focused and decrease in emotion-focused coping (Buchi et al., 1997; Gift & Austin, 1992; Ninot et al., 2006) associated with successful inpatient rehabilitation. These studies are promising inasmuch as they suggest that interventions targeted to increase adaptive coping might be effective in improving short- and long-term well-being. Furthermore, interventions such as cognitive-behavior therapy have been successfully used to increase task-oriented coping among adults with TBI (Anson & Ponsford, 2006a, 2006b).

Coping and well-being after TBI. Few studies examine how coping style relates to subjective outcomes, such as satisfaction with life, and functional outcomes, such as physical disability, for individuals following moderate to severe TBI. Given the high prevalence of cognitive and emotional deficits in individuals with moderate to severe TBI, the three-factor structure of coping (i.e., problem-focused, emotion-focused, avoidant) might not hold up in this population as such deficits may influence patients' ability to respond to and cope with stress (Moore & Stambrook, 1995). For example, Curran and colleagues' (2000) study of coping and emotional outcome after TBI reported that nonproductive coping (akin to emotion-focused coping) was strongly related (*r*s .60 – .80) with self-esteem, depression and trait anxiety. The latter three characteristics were considered as "outcomes" in this study, but it is noteworthy that those characteristics predicted level of handicap as well or better as measures of coping did. Findings such as these raise questions about whether coping style is a distinct, multidimensional construct in TBI. Like specific cognitive functions are driven by global cognitive impairment in TBI, assertions of uniqueness and specificity for coping must be empirically demonstrated. Most studies focus exclusively on the relationship between coping and outcomes of interest and do not examine

relationships of other psychological constructs to coping or to the outcomes of interest. Thus, most studies of coping in TBI do not show discriminant validity by accounting for overarching personality characteristics such as general negative affectivity (i.e., as might be observed in measures of depression, trait anxiety, or self-esteem) that could explain phenomena attributed to specific ways of coping.

Cognitive deficits may alter the ways in which people with TBI think about and engage in coping (Godfrey, Knight, & Partridge, 1996). Task-oriented coping is positively associated with physical and psychological well-being outcomes, but it requires higher-order cognitive functioning, such as planning, prioritizing, and following through; these cognitive skills are frequently impaired after TBI. Although little research has examined this hypothesis, one study (Krpan, Levine, Stuss, & Dawson, 2007) observed that executive functioning was positively associated with problem-focused coping and inversely associated with emotion-focused coping among 21 adults with TBI at 1 year post injury. This general concept has been supported in other populations as well. For example, studies have reported that individuals who have multiple sclerosis (Rabinowitz & Arnett, 2009) or schizophrenia (Wilder-Willis, Shear, Steffen, & Borkin, 2002) and cognitive deficits such as executive dysfunction inadequately utilized adaptive coping strategies to handle stress. Among patients with Parkinson's disease, impaired cognition predicted low use of task-oriented coping, which in turn predicted poor subjective well-being and health-related quality of life (Hurt et al., 2012).

Persons with TBI also very often have memory impairments (Dikmen et al., 2009) that may affect their coping styles in the moment, such as having difficulty recalling information necessary to take action when in negative or stressful situations. Memory deficits also may affect the ability to recall coping responses when later assessed through standard self-report measures.

Given that they are at a heightened risk for emotional disturbance following injury, people with TBI may be more likely to engage in passive, emotion-focused coping strategies rather than action-oriented coping strategies, particularly patients who have low frustration tolerance post injury. Additionally, the trauma sequelae associated with TBI often include physical and functional disabilities that might adversely affect ways of coping, particularly if individuals have limited physical mobility that may be necessary for problem-solving and adaptive coping in some stressful situations.

With TBI individuals often experience anosagnosia (impaired awareness of their deficits) and may not recognize a need to invoke coping strategies or other compensatory efforts in challenging situations that require problem-solving or task-oriented coping. People with TBI with impaired awareness of their deficits are more likely to engage in avoidant coping strategies during recovery and have higher levels of depression as compared to patients who recognize their deficits (Kortte, Wegener, & Chwalisz, 2003). In fact, a rare intervention study conducted on 33 adults with TBI showed improvements in adaptive coping after a targeted coping skills group; according to the authors, the main finding was that improved outcomes linked to the intervention were associated with increased self-awareness of deficits (Anson & Ponsford, 2006a, 2006b).

Some evidence suggests that people with TBI and matched trauma or non-neurological patient controls have similar patterns of coping, which calls into question whether persons with TBI cope with stress after injury differently than other medical populations (Curran et al., 2000; Malia, Powell, & Torode, 1995). For instance, some researchers have suggested that pre-injury characteristics may play a larger role than injury type in preferred coping styles, such as personality traits or demographic factors (Moore & Stambrook, 1995).

The extent to which specific coping styles are adaptive for long-term physical and psychological well-being may differ for chronic, unsolvable situations as compared to resolvable situations (Folkman & Moskowitz, 2004). Given a resolvable conflict, an action-oriented strategy might produce a favorable outcome; however, given an unresolvable conflict, multiple failed attempts to resolve the situation could add to the stress of the conflict itself. In contrast, given a chronic, unresolvable stressor such as TBI, emotion-focused coping might be most adaptive, inasmuch as emotional reactions are comparatively more manageable and release of negative emotion can be beneficial (Kendall & Terry, 2008). It also is possible that differences in coping styles and outcomes arise from patients' perceptions of controllability in post-injury events, which may be distorted by cognitive deficits associated with TBI. In fact, there are mixed findings regarding the usefulness of problem-focused coping in situations that patients' perceive as controllable, such that some patients had better emotional functioning (Moore & Stambrook, 1995) and others had increased emotional distress (Kendall & Terry, 2008). In this regard, different types of outcomes might be differently associated with coping styles; for example, task-oriented coping might be most beneficial for functional outcomes, whereas emotion-focused coping might be most beneficial for outcomes involving subjective well-being.

Measurement of coping. A variety of scales are available to assess coping in general populations. Among them, the *Ways of Coping* scale, in its current version called the *Ways of Coping Questionnaire,* by Folkman and Lazarus (Folkman & Lazarus, 1985, 1988) was the forerunner and considered the gold standard for many years. It has been studied and critiqued extensively in the literature, and although it still holds a special place in research due to familiarity and wide use, it does not appear to be among the strongest options psychometrically (Edwards & O'Neill, 1998; Kieffer & MacDonald, 2011; Lunqvist & Ahlström, 2006). For example, numerous

factor structures have emerged, few of which align with the theoretical structure on which the scale was developed (Dikmen et al., 2009; Edwards & O'Neill, 1998; Kieffer & MacDonald, 2011). Although a recent reliability generalization meta-analytic review of 130 studies using this scale found that several of the subscales demonstrate fairly stable reliability (i.e., > .70), the scale shows numerous problems with reliability and generalizability across conditions and demographics, such as population type (e.g., community, inpatient, outpatient), sample size and source, gender and racial homogeneity (Kieffer & MacDonald, 2011).

The *Coping with Problems Experienced* scale (COPE) is a popular option that is generally psychometrically sound when used to assess coping (Carver, Scheier, & Weintraub, 1989). The full version of the COPE provides 15 theoretically driven scales assessing a range of functional and dysfunctional coping strategies. A similar set of factors has emerged across multiple studies conducted independent of the test authors, although scales tapping problem-focused and emotion-focused strategies frequently load on the same factor (Litman, 2006), and the test authors do not endorse combining the 15 scales into aggregated dimensions such as problem-focused and emotion-focused coping (Carver, 2012). In these regards, both the Ways of Coping and COPE scales have been faulted for being lengthy and complex, which are especially important considerations in selecting measures appropriate for people with moderate to severe TBI (e.g., cognitive load and fatigue). In particular, Carver and colleagues found that patients completing the full COPE often became impatient with the redundancy and length of the measure (Carver, 1997). A brief version of the COPE was developed to address these concerns (Carver, 1997); unfortunately, the scale did not hold up well psychometrically when used to assess adults with even mild TBI, showing poor fit with its theoretical nine-factor structure and low reliabilities for several of the abbreviated scales (Snell, Siegert, Hay-Smith, & Surgenor, 2011).

The *Coping Inventory for Stressful Situations (CISS)*, called the *Multidimensional Coping Inventory (MCI)* in its original form, was developed by Endler and Parker (1990) as a psychometrically stronger alternative to assessing coping style compared to prior measures, such as the *Ways of Coping Checklist (WCC)* or the *COPE*. The CISS is comprised of 48 items, as opposed to 66 items on the WCC or 60 items on the COPE, making it markedly shorter than previously established coping measures. This measure was designed with three subscales to assess problem-focused, emotion-focused, and avoidant-focused coping styles. The authors' original validation studies with undergraduates revealed that the CISS subscales had high internal consistency reliabilities, with *r*s between .76 and .91 (Endler & Parker, 1990). Furthermore, in order to assess construct validity for the MCI, the authors examined the MCI and WCC, which are based on similar theory for conceptualizing coping; among undergraduates, they found that the subscales of each measure correlated meaningfully. They also found that when analyzed jointly, the resulting factor structure was consistent with the proposed three-factor design of the MCI, reflecting problem, emotion, and avoidant coping orientations (Endler & Parker, 1990). Additionally, the authors found support for the multidimensionality of the coping as measured by the MCI in that coping scales associated meaningfully with multiple measures of depression, anxiety, and personality characteristics, as supported in prior work, such as depression levels moderating amount of emotion coping reported (Endler & Parker, 1990). They also found strong evidence of multidimensionality of the MCI using factor analysis, which yielded the proposed task, emotion, and avoidant coping styles (Endler & Parker, 1990). Also of interest for test selection, comparing results of the Marlow-Crowne Social Desirability Scale (Crowne & Marlowe, 1960) and the MCI, the authors found that among undergraduates there was little association between social desirability scores and endorsement of task, emotion, or avoidant coping on this measure

(Endler & Parker, 1990). It also is important to consider potential effects of gender on coping responses to stressors, given differences established that show men and women often report using different approaches, such that women often report engaging in more emotion and avoidant coping, by nature of social support seeking, than do men (Endler & Parker, 1990).

Additional research using the CISS supports its psychometric properties as a multidimensional measure of coping style among healthy populations both within the United States and internationally. For example, Cosway et al. (2000) examined the reliability, factorial structure, and predictive validity of the CISS among 730 healthy Scottish doctors and farmers. These researchers found strong support for the reliability of the CISS and for the three-factor structure of coping proposed by Endler and Parker (1990) (i.e., task, emotion, and avoidance oriented coping), as well as support for the division of the avoidance oriented coping scale into distraction and social diversion subtypes (Cosway et al., 2000). This study also found support for the predictive validity of the CISS in relation to indicators of personality and psychological distress, particularly noting replication of neuroticism relating positively to emotion-oriented coping and negatively to task-oriented coping (Cosway et al., 2000). Moreover, the three-factor structure of the CISS has been replicated using an Icelandic version of the measure among 1251 adolescents (Rafnsson, Smari, Windle, Mears, & Endler, 2006). This study also found strong evidence of the reliability for the CISS scales as well as further evidence of construct validity as evidenced by the relationships between the CISS scales and measures of neuroticism and extraversion (Rafnsson et al., 2006). Furthermore, a Japanese version of the CISS was examined using samples of 33 university students and 2550 high school students and was found to demonstrate good reliability and validity as a measure of coping in this population (Furukawa, Suzuki-Moor, Saito, & Hamanaka, 1993); in particular, this study found evidence of content,

concurrent and predictive validity of the Japanese version of the CISS (i.e., *J-CISS*). Furukawa et al. (1993) also found support for the proposed three-factor structure of coping purportedly measured by the CISS. Similarly, Boysan (2012) examined a Turkish version of the CISS among 729 college students and found support for the propose multi-dimensional structure of the measure, as well as evidence of its reliability and validity as a measure of coping in this sample.

Furthermore, studies using the CISS among clinical populations have provided added support for the psychometric properties of the CISS and utility of the measure for assessing multiple aspects of coping style. For instance, among persons with major depressive disorder, McWilliams et al. (2003) found support for the reliability, validity, and proposed factor structure of the CISS. Similarly, Hurt et al. (2011) found support for the reliability and validity of the CISS as a measure of coping among a large sample of persons with Parkinson's disease. Overall, the CISS has been shown to be a reliable and valid measure of coping in healthy adults across multiple cultures and in several clinical populations.

Coping responses have been examined among people with TBI, although the measures used to assess coping have not been not well validated for use in this population. For example, Anson and Ponsford (2006a) assessed coping style among 33 adults with TBI using the Coping Scale for Adults (CSA), an Australian measure of coping style, and examined associations among coping style, stress, and emotional adjustment. Similarly, Curran et al. (2000) also used the CSA in a study of coping comparing 88 TBI patients with 40 serious orthopedic injury patients. In a study looking at post-traumatic stress disorder among persons with severe TBI, researchers employed the Coping Style Questionnaire in efforts to identify predictors of distress and functioning after injury (Bryant, Marosszeky, Crooks, Baguley, & Gurka, 2000). Malia et al. (1995) used the familiar Ways of Coping Checklist to assess coping among a mixed group of adults

with neurologic disorders involving acquired brain impairment (TBI, stroke, and various other causes) and matched controls, and they found the measure to be highly reliable in these groups. This study also described the factor structure for this scale as used with a neurologically impaired sample as being relatively consistent with the general coping literature, identifying problem-focused, emotion-focused, avoidance, and wishful thinking coping styles (Malia et al., 1995). Thus, this study provides preliminary support for reliable and valid measurement of distinct coping styles among persons with TBI. However, the Ways of Coping Checklist in general has inconsistent psychometric support, which makes it a less desirable option to pursue in identifying a psychometrically sound measure of coping among persons with TBI.

Although some studies have examined coping style in this population, there is limited research to identify a reliable and valid measure of coping in individuals with TBI. Overall, most studies that have examined coping style in persons with TBI have falsely assumed that reliability generalized from psychometric support established for non-TBI populations, which underscores the need for the current study to specifically examine the reliability, validity, and utility of the CISS for use among persons with TBI (Kieffer & MacDonald, 2011).

Purpose and Hypotheses. Identifying a psychometrically sound measure of coping style in individuals with TBI is an essential step in expanding our understanding of the role of coping style and TBI recovery. This research has the potential to influence TBI rehabilitation programs through focus on appropriately targeting coping style in psychological treatment, which has shown some promise in recent research (Anson & Ponsford, 2006a). The present study aimed to examine the psychometric properties of the Coping Inventory for Stressful Situations (CISS) as used with individuals with moderate to severe TBI. It is expected that the CISS has adequate reliability as a measure of coping style in individuals with TBI *(Hypothesis 1)*. It was expected that the CISS

would show a multi-factorial structure of coping style in individuals with TBI *(Hypothesis 2)*. Secondly, this study aimed to examine the relationship between coping style and recovery from TBI, including subjective and objective (functional) well-being outcomes. It was expected that the CISS would show sound criterion-related validity, as demonstrated by meaningful association with subjective and functional outcomes following TBI *(Hypothesis 3)*. Lastly, it was expected that the CISS uniquely predicts subjective and functional outcomes following TBI after accounting for injury severity and sociodemographic factors *(Hypothesis 4)*.

CHAPTER 2

METHOD

Participants

Participants were 331 adults (270 men, 61 women) who sustained a moderate to severe TBI. This study examined archival data for persons with TBI who participated in the Southeastern Michigan Traumatic Brain Injury System (SEMTBIS) research, which is part of the Traumatic Brain Injury Model Systems (TBIMS). Individuals who qualified for the SEMTBIS research were at least 16 years old at the time of injury, but for the purpose of this study, individuals were at least 18 years old at the time of participation. Additionally, individuals included in the SEMTBIS research had a medically documented TBI, received treatment at an affiliated Level-I trauma center within 24 hours of injury, were discharged to a model system inpatient rehabilitation facility, and gave informed consent. Individuals were not included for the SEMTBIS research project if they had mild injuries and did not require inpatient rehabilitation, or if they had very severe injuries and would not benefit from inpatient rehabilitation. Therefore, individuals with mild or very severe TBI were not included in this study. Persons also were excluded if their injuries resulted from anoxic encephalopathy or if they were non-English speaking.

Age of the participants ranged from 18 to 90 years (M = 44.0, SD = 13.5). Education of the participants ranged from 6 to 18 years (M = 11.9, SD = 2.1). These participants identified themselves as Caucasian (26.3%), African-American (70.7%), Latino(a) (1.5%), Native American (0.9%), or Asian or Pacific Islander (0.6%). Participants completed this study between 1 and 15 years after injury (M = 6.1, SD = 4.9). For most analyses in this study, participants assessed at five or more years after injury were combined to form a “chronic” group; this decision reflected research showing that the most appreciable gains in recovery following TBI occur in the first few

years and that abilities and deficits often stabilize at the further time points, making comparisons across recovery times most clinically meaningful among years 1, 2, and chronic times. Assessments with participants for the present study reflect cross-sectional follow-ups completed at 1 year (n = 62), 2 years (n = 64), 5 years (n = 93), 10 years (n = 61) and 15 years (n = 51) post injury, which coincided with the scheduled assessments for the SEMTBIS. On average, participants in this study had a Glasgow Coma Scale (GCS) total at admission of 9.3 (*SD* = 4.2, *range* = 3 to 15), which corresponds to a moderate injury. GCS scores from 13 to 15 typically are considered to reflect mild injuries; however, research indicates that persons with GCS scores in this range who have documented lesions on neuroimaging have neuropsychological profiles more similar to persons with moderate TBI (Levin et al., 1987) than uncomplicated mild TBI. Days from injury to follow commands as indicated from the motor subscale of the GCS is considered to be one of the best indicators of brain injury severity (Elovic, Baerga, & Cuccurullo, 2004). Days from injury to follow commands in this sample averaged 7.2 days (*SD* = 12.0, *range* = 0.5 to 99). Disability ratings at discharge as measured by the Disability Rating Scale (DRS) averaged 6.5 (*SD* = 2.9, *range* = 0 to 20). Table 1 presents demographic, injury-related, and psychosocial characteristics of the sample.

Measures

Coping Inventory for Stressful Situations (CISS). The CISS (Endler & Parker, 1990) is a 48-item self-report measure that uses a 5-point scale (1 = *not at all* to 5 = *very much*). The CISS provides three 16-item scales to assess specific coping styles: Task, Emotion, and Avoidance coping. The Avoidance scale can be divided into two subscales, Distraction and Social Diversion. Although the CISS has not been widely used in TBI research, this scale has been shown to be a reliable and valid measure of coping in healthy populations (Endler & Parker, 1990) and distressed

populations (McWilliams et al., 2003). The CISS was the primary measure of interest in this study to identify a reliable and valid measure of coping among persons with TBI.

Glasgow Coma Scale (GCS). The GCS (Teasdale & Jennet, 1974) is a scale used by medical professionals to assess the degree of consciousness among trauma or acute care patients. Patients are rated on a multi-point scale in three domains: eye response (1 = *no response* to 4 = *full response*), verbal response (1 = *no response* to 5 = *full response*), and motor response (1 = *no response* to 6 = *full response*). GCS scores range from 3 to 15, with a score of 3 indicating coma or death and a score of 15 indicating full consciousness. GCS scores of 9 to 12 indicate moderate TBI and scores of 3 to 8 indicate severe TBI. In this study, the GCS was used as an indicator of injury severity.

Post-traumatic amnesia (PTA). PTA refers to the length of time that patients experience confusion and disorientation following TBI during which they cannot remember events that occur after the injury. In this study, PTA also was used as an indicator of injury severity. Both GCS and PTA commonly are used to assess TBI severity (Dawson et al., 2004).

Satisfaction with Life Scale (SWLS). The SWLS (Diener, Emmons, Larsen, & Griffin, 1985) is a 5-item self-report measure that uses a 7-point scale (1 = *strongly disagree* to 7 = *strongly agree*) to assess general life satisfaction based on the perspective and judgment of the individual. On the SWLS, high scores reflect high life satisfaction. The SWLS has been used extensively in TBI research (Corrigan et al., 2001) and has been shown to be a reliable and valid measure of life satisfaction in non-medical and medical populations (Arrindell, Meeuwesen, & Huyse, 1991; Pavot & Diener, 1993). The SWLS was the primary measure of subjective well-being in this study.

Disability Rating Scale (DRS). The DRS (Rappaport, Hall, Hopkins, Belleza, & Dope, 1982) is an 8-item scale that is administered to patients by trained raters to assess impairment and

disability during the recovery process. According to Rappaport and colleagues (1982), the DRS assesses four main areas: arousal and awareness, cognitive ability to handle self-care functions, physical dependence upon others, and psychosocial adaptability for work, housework, or school. The DRS is used commonly with TBI and has been shown to be a reliable and valid measure of functioning in patients with TBI (Gouvier, Blanton, LaPorte, & Nepomuceno, 1987; K. M. Hall, Hamilton, Gordon, & Zasler, 1993). The DRS was the primary measure of objective, or functional, well-being in this study.

Demographic and other information. Examiners collected information regarding age, gender, and level of education for all participants.

Procedure

This study adhered to the Wayne State University Institutional Review Board guidelines regarding research using archival data. This study used archival data from the Southeastern Michigan Traumatic Brain Injury System (SEMTBIS) database, which is a comprehensive longitudinal database associated with the larger Traumatic Brain Injury Model Systems (TBIMS) project. Examiners recruited persons with TBI who met eligibility qualifications before patients were discharged from inpatient rehabilitation. Eligible patients who gave informed consent completed a comprehensive assessment associated with the SEMTBIS project. Patients were followed for 1, 2, 5, 10, and 15 years post injury, at which times they underwent follow-up assessments as part of the SEMTBIS project. Patients were compensated monetarily at each time point.

Analyses

To address *Hypothesis 1* (the CISS is a reliable measure of coping style among individuals with TBI), internal consistency of the CISS scales and overall measure were assessed using

Cronbach's alpha across time since injury (i.e., 1, 2, 5, 10 or 15 years), overall (i.e., total sample), and disability level (i.e., no disability, mild, partial, or moderate-severe). Mixed-model ANOVAs and post-hoc comparisons also were conducted to compare reliability estimates across these subsamples and scales. Additionally, the measurement properties of the CISS were assessed using Rasch analyses, including obtaining estimates of measure reliability.

To address *Hypothesis 2* (multidimensional structure of the CISS), bivariate correlations of the CISS scales were assessed to examine the relationship among different coping styles and to see how well the established three-factor structure held up in this population. Rasch analyses also were conducted to address the dimensionality questions inherent to this hypothesis. Models of interest to compare included the widely accepted three-factor model, a unifactorial model, and a null model.

To address *Hypothesis 3* (criterion-related validity), bivariate correlations were conducted between the CISS scales and both the SWLS and the DRS. To address *Hypothesis 4* (incremental validity), hierarchical multiple regression analyses assessed the utility of CISS scales in accounting for subjective and functional outcomes of TBI after accounting for demographic and injury severity factors.

CHAPTER 3

RESULTS

Hypothesis 1

Hypothesis 1 predicted that the CISS has adequate reliability as a measure of coping style in individuals with TBI.

Classical Test Theory Evaluation of the CISS Reliability

Table 2 presents Cronbach's alpha coefficients and descriptive statistics of the CISS scales for the total sample and separately for each of the follow-up years. Overall, for the total sample, different patterns were observed for the raw scores and normative scores. The normative scores indicated that this sample used less Task (z = -0.15) and more Emotion (z = +0.36) and Avoidant (z = +0.27) coping compared to healthy community dwelling men and women. However, in terms of absolute values (raw scores) on the scales, this sample used more Task (M = 57.3) than Emotion (M = 44.1) and Avoidant (M = 41.9) coping, which is consistent with the pattern reported among the normative sample (Endler & Parker, 1999).

Reliability of the CISS *Task* scale for the total sample as assessed by Cronbach's alpha was .91, indicating excellent reliability (Cicchetti, 1994). Examination of the distributions of the items in the Task scale indicate that each item was endorsed across the full range of response alternatives (i.e., 1 = *not at all* to 5 = *very much*); as shown in Table 2, the item mean for the scale (3.58, SD = 0.30) corresponds to a level between "somewhat" and "quite a bit." Corrected item-total correlations (i.e., discriminant indices) for the Task scale in the total sample ranged from .47 (Item 1, "In stressful situations, I schedule my time better") to .67 (Item 24, "In difficult situations, I work to understand the situation"). Thus, all items far exceeded the criterion for retention based on discriminant indices (DI) > .30 (Nunnally & Bernstein, 1994).

Reliability of the CISS *Emotion* scale for the total sample as assessed by Cronbach's alpha was .89, indicating good reliability. Examination of the distributions of the items in the Emotion scale indicate that each item was endorsed across the full range of response alternatives; as shown in Table 2, the item mean for the scale (2.76, SD = 0.44) corresponds to a level between "very little" and "somewhat." Corrected item-total correlations (i.e., discriminant indices) for the Emotion scale in the total sample ranged from .39 (Item 33, "In difficult situations, I tell myself that it will never happen again") to .66 (Item 19, "In difficult situations, I become very upset"). Thus, all items exceeded the criterion for retention based on discriminant indices (DI) > .30.

Reliability of the CISS *Avoidance* scale for the total sample as assessed by Cronbach's alpha was .84, indicating good reliability. Examination of the distributions of the items in the Avoidance scale indicate that each item was endorsed across the full range of response alternatives; as shown in Table 2, the item mean for the scale (2.62, SD = 0.60) corresponds to a level between "very little" and "somewhat." Corrected item-total correlations (i.e., discriminant indices) for the Avoidance scale in the total sample ranged from .30 (Item 23, "In stressful situations, I go to a party") to .59 (Item 13, "In stressful situations, I feel anxious about not being able to cope"). Item 23 was the only item that produced a discriminant index below the criterion for retention, discriminant indices (DI) > .30, but item-deleted alpha statistics indicated that deletion of this item would not improve the overall alpha of the scale.

Reliability of the CISS *Distraction* subscale for the total sample as assessed by Cronbach's alpha was .79, indicating acceptable reliability. Examination of the distributions of the items in the Distraction subscale indicate that each item was endorsed across the full range of response alternatives; as shown in Table 2, the item mean for the scale (2.39, SD = 0.46) corresponds to a level between "very little" and "somewhat." Corrected item-total correlations (i.e., discriminant

indices) for the Distraction subscale in the total sample ranged from .26 (Item 44, “In stressful situations, I take some time off and get away from the situation”) to .62 (Item 18, “In stressful situations, I go out for a snack or meal”). Item 44 was the only item that produced a discriminant index below the criterion for retention, discriminant indices (DI) > .30, and item-deleted alpha statistics indicated that deletion of this item would improve the overall alpha of the scale only by .01.

Reliability of the CISS *Social Diversion* subscale for the total sample as assessed by Cronbach’s alpha was .77, indicating acceptable reliability. Examination of the distributions of the items in the Social Diversion subscale indicate that each was endorsed across the full range of response alternatives; as shown in Table 2, the item mean for the scale (3.01, SD = 0.42) corresponds to a level between “somewhat” and “quite a bit.” Corrected item-total correlations (i.e., discriminant indices) for the Social Diversion subscale in the total sample ranged from .43 (Item 4, “In upsetting situations, I try to be with other people”) to .60 (Item 31, “In upsetting situations, I spend time with a special person”). Thus, all items exceeded the criterion for retention based on discriminant indices (DI) > .30.

CISS Reliability Across Time Since Injury

As part of addressing *Hypothesis 1*, descriptive analyses were conducted to examine CISS reliability across time since injury and demographic characteristics. Table 2 shows the Cronbach’s coefficient alpha reliabilities for the CISS scales across time since injury for TBI participants at 1, 2, 5, 10, and 15 years post injury and shows scale and item means across follow-up years and CISS scales. Among the follow-up years, the Task scale alpha reliabilities ranged between .89 (Year 10) and .93 (Year 2) (Table 2). Univariate ANOVA indicated that mean scores on the Task scale did not differ significantly across the follow-up years, with scores ranging between 55.20 (Year 15)

and 59.12 (Year 5) (Table 2). Across time since injury, the Emotion scale alpha reliabilities ranged between .86 (Years 2 and 10) and .93 (Year 15) and mean scores did not differ significantly across time points, with scores between 41.17 (Year 2) and 45.75 (Year 5) (Table 2). Similarly, the Avoidance scale alpha reliabilities ranged between .80 (Year 15) and .89 (Year 1) and mean scores did not differ significantly across follow-up times, with scores between 40.17 (Year 2) 44.47 (Year 1) (Table 2). The reliabilities and scale means for the subscales of the Avoidance scale, Distraction and Social Diversion, also were examined. The Distraction subscale alpha reliabilities ranged between .73 (Year 15) and .84 (Year 2) and mean scores differed non-significantly between 18.03 (Year 2) and 20.24 (Year 1) (Table 2). The Social Diversion subscale alpha reliabilities ranged between .68 (Year 10) and .80 (Years 1, 2, and 5) and mean scores also differed non-significantly between 13.67 (Year 15) and 15.95 (Year 1) (Table 2). Additionally, a "unidimensional" total CISS mean score did not differ across the follow-up years and alpha reliabilities ranged between .88 (Year 5) and .93 (Years 1 and 15) (Table 2).

Overall, the reliabilities for the CISS scales were good to excellent across all follow-up year groups, exceeding .90 for Task and .80 for the Emotion and Avoidance scales. Reliabilities For the briefer Distraction and Social Diversion subscales fell, most critically (i.e., .68 to .74) among the chronic-year participants. Notably, the unidimensional (all items) scale reliabilities also exceeded .80 for all follow-up year groups.

CISS Reliability Across Disability Severity

A second series of analyses examined Cronbach's alpha reliabilities of the CISS as a function of current level of disability, assessed via Disability Rating Scale (DRS). Participants were grouped according to DRS categories: No disability (n = 78), mild (n = 78), partial (n = 79), and moderate/moderate-severe (n = 80). Only 9 cases met DRS criteria for "moderately severe"

disability (DRS 7 – 11); therefore, these cases were combined with the moderate category. Results of these analyses are presented in Table 3.

A mixed-model ANOVA with DRS Group as the between-subjects variable and CISS Scale as the within-subject variable indicated main effects of CISS Scale $F(3, 310) = 20.47$, $p < .001$, partial $eta^2 = .12$, and DRS Group $F(3, 311) = 7.15$, $p = .047$, partial $eta^2 = .03$, and a Group x CISS Scale interaction, $F(6, 620) = 8.39$, $p < .001$, partial $eta^2 = .08$. Figure 1 depicts the interaction of the CISS scales, converted to Z scores using the normative data provided in the test manual (Endler & Parker, 1999). As depicted in the figure and detailed in Table 3, post hoc univariate ANOVAs and Tukey tests ($p < .05$) for each of the scales indicated that use of Task coping generally decreased as disability increased, whereas Emotion coping generally increased as a function of disability, and Avoidance coping was statistically equivalent across the groups. The group with no disability scored significantly higher on Task coping than the Partial and Moderate-Severe groups; the Mild group scored higher than Partial disability group; whereas the Partial and Moderate-Severe groups did not differ significantly. The group with no disability reported significantly less Emotion coping than did the Partial and Moderate-Severe groups; there was a meaningful trend between no disability group reporting less Emotion coping as compared to the Mild group ($p = .09$) and between the Mild group reporting less Emotion coping than the Moderate-Severe group ($p = .11$), but the Partial disability and Moderate-Severe groups were statistically equivalent.

The differences between the Cronbach's coefficient alphas across the groups were tested (Charter & Feldt, 1996). Tests comparing differences between correlations are sensitive to the absolute magnitudes of the correlations as well as power associated with group sizes; small differences between high-magnitude correlations will reflect larger differences in variance as

compared to low-magnitude correlations. For example, the .05 difference between correlations of .95 and .90 represents 9.2% variance (90.2% – 81.0%), whereas the same .05 difference between correlations of .55 and .50 represents 5.5% variance (30.2% - 25.0%). Therefore, although most of the absolute differences were small, Cronbach's coefficient alpha on the Emotion scale for the Moderate-Severe group (.83) was significantly lower ($p < .05$) than among the Mild (.90, $p = .010$) and Partial (.92, $p < .001$) groups. A similar pattern was observed on the Avoidance scale, in which coefficient alpha for the Moderate-Severe group (.81) was significantly lower than that observed for did the Mild group (.87, $p = .048$), with a similar trend as compared to the Partial disability group (.96, $p = .09$). Of note, coefficient alpha on the Emotion scale for the group with no disability (.84) also was significantly lower than that observed for the Mild ($p = .020$) and Partial ($p = .001$) disability groups. All other comparisons for the CISS scale alpha reliabilities across disability levels were statistically equivalent.

Rasch Analysis of the CISS

Although most analytic approaches require interval level data to draw inferences, most measures used in social science research have not been developed or demonstrated to meet such expectations of fundamental measurement. The coping literature is no exception to this observation. Rasch analyses belong to a family of approaches classified under Item Response Theory (IRT), in contrast to approaches consistent with Classical Test Theory (CTT). Theoretically, Rasch modeling differs from traditional CTT approaches in that models are developed with the primary goal of establishing an ideal scale with interval level measurement and examining how well the data fit the model, in contrast to striving to develop a model to describe the data, as with CTT approaches.

In this study, to further address *Hypothesis 1*, the measurement properties of the CISS in

persons with TBI were examined using Rasch analyses. Rasch modeling allows for examination of item level and whole measure functioning as well as providing information about the dimensionality of a measure to determine whether the scale best reflects a unidimensional measure, in which the distribution of residuals is relatively normal, or more likely reflects a scale tapping multiple facets. Examining the dimensionality of the CISS is of particular interest to determine whether the three-factor structure of the CISS proposed by the authors of the scale holds up when stringently examined using Rasch analyses. Alternatively, Rasch analyses might provide information to suggest a different underlying structure of the scale, such as a unidimensional model. In a practical sense, Rasch analyses allow for careful item and category evaluation to determine whether the measure might function better than in its current form with changes to the number of items or structure of category response options. For instance, results might lend support for the current 48-item, five-category CISS item structure, which includes Category 1 (*"not at all"*), Category 2 (*"very little"*), Category 3 (*"somewhat"*), Category 4 (*"quite a bit"*), and Category 5 (*"very much"*). Alternatively, results might suggest that the CISS might work better if some items were dropped or some category options collapsed. Ultimately, the goal of the Rasch analyses in this study is to improve understanding about how the CISS holds together as a measure among persons with TBI and to determine whether the CISS functions best in its original form or if alterations might improve its measurement properties.

In this study, three longitudinal time conditions to assess TBI recovery were examined: 1 year post injury, 2 years post injury, and chronic time period post injury (5, 10, and 15 years post injury). For each time point, Rasch analyses were conducted for each of the proposed three CISS scales, Task-oriented coping, Emotion-oriented coping, and Avoidance-oriented coping. In addition, Rasch analyses were conducted at each time condition using all 48 items of the CISS in

order to examine the dimensionality of the CISS comprehensively, particularly examining whether the CISS might actually function as a unidimensional measure versus the proposed multi-dimensional model.

With each set of Rasch analyses, the same general approach was used to assess measure function and item fit with the model. In many ways, Rasch modeling is as much an art as a science in regards to making judgments about which criteria levels to employ given the theoretical basis for the items or scale and about how to interpret different output in concert to understand the measure function. The Rasch analyses for this study followed a general framework outlined by Bond and Fox (2007) and adhered to certain guidelines and criteria recommended by these authors, which are described and cited in this study as encountered. For this study, Rasch analysis of the CISS examined *unidimensionality*, *reliability*, *targeting*, and *response categories*.

Rasch Analysis of CISS: Chronic (Years 5, 10, 15), All Items

Unidimensionality and Model Fit

Two important statistics in Rasch modeling are *infit* and *outfit*. *Infit* refers to "information-weighted" or "inlier-sensitive" fit. Infit is a weighted fit statistic of overall performance of an item or person that is expressed in terms of the (squared) deviation of observed performance from expected performance (Linacre, 2002; Wright & Linacre, 1985). *Outfit* refers to "outlier-sensitive" fit. Outfit is an unweighted statistic that reflects the extent to which outliers are present in the model and is also expressed in terms of (squared) deviations of observed performance from expected performance. The metrics of infit and outfit statistics are weighted and unweighted normalized mean-squares, respectively (Linacre, 2002; Wright & Linacre, 1985).

When data are predicted well by the Rasch model, infit and outfit mean-square values approximate the expected value of 1.0, with extreme values ranging from 0 to infinity. When data

poorly fit the model (unpredictability), fit statistics are greater than 1.0, and when data over fit the model (redundancy), fit statistics are lower than 1.0. Generally, items that poorly fit the model (high fit statistics) are more problematic than items that over fit the model (low fit statistics), and poor infit mean-square values are more problematic than poor outfit mean-square values (Wright & Linacre, 1994). There are no set cut points to determine misfitting items in general but guidelines exist to select value ranges based on the purpose of the analyses; for example, high stakes analyses necessitate more stringent cut points than do survey level analyses (Wright & Linacre, 1994). In this study, the CISS was used for measurement of coping among TBI patients and for examining relationships among coping styles and functional and subjective outcomes for these patients. These measurement purposes have implications for assessment and prediction of real-world functions for persons with TBI, which make the use of the CISS in this context more important than that of a general survey test although involving fewer risks than that of a high stakes testing context. Therefore, based on expert recommendations, good item infit and outfit mean-square values were selected to range from 0.7 to 1.3 (Fisher, 2007; Wright & Linacre, 1994).

The infit and outfit mean-square values for all 48 items of the full CISS at each follow-up time period are shown in Table 7. The infit and outfit mean-square values for scale-specific items at each follow-up time period are shown separately with data for Task-oriented coping in Table 8, data for Emotion-oriented coping Table 9, and data for Avoidance-oriented coping in Table 10. Additional diagnostic data from all Rasch analyses are shown in Table 11, including person and item separation ratios and reliability estimates, variance explained by measures, and unexplained variance explained by first contrast.

For the full (i.e., unidimensional) CISS at the chronic time period, all items showed good fit with the model based on infit and outfit mean-square values except for Item 23, which showed

slight misfit with an infit mean-square value of 1.31 and outfit mean-square value of 1.36 (Table 7). Correlations between items and measures were examined by looking at the Item Statistics table in Winsteps (Table 10.1 in the output) for all Rasch analyses conducted in this study. Items that reflect the underlying construct assessed by the measure are expected to show positive and strong correlations with the measure. Items that do not reflect the underlying construct of the measure are expected to show negative or weak correlations, or in the case of negative correlations, might suggest problems with the direction of keying item responses. For the full CISS at the chronic time period, there were no problems with negative or weak correlations between items and measure, with correlations between .19 (Item 23) and .57 (Item 34).

Variance explained by the measure should approximate 60% or greater according to (Fisher, 2007). For the full CISS at the chronic time period, the first factor representing the Rasch model accounted for 32.8% of the variance in the measure, which although well below the acceptable range, this value approximated the modeled value of 32.9% (Table 11).

Furthermore, the unexplained variance explained in the first contrast of principle components analysis of residuals should reflect an eigenvalue < 3, which is consistent with Rasch model expectations for measure unidimensionality (Fisher, 2007). This value indicates the strength of the largest residual contrast and can be conceptualized as having the strength of that many items if the contrast were paralleled with the concept of a dimension. For the full CISS at the chronic time period, this value was 8.1, which was much greater than desired for a unidimensional scale.

In order to determine if the functioning of this measure might improve with the deletion the one slightly misfitting item, these analyses were rerun without Item 23. Without Item 23, the model accounted for 31.5% of the variance in the measure, which approximated the modeled 31.6%, both of which remained below the acceptable range. The unexplained variance explained

in the first contrast for this altered model was 8.0, well above the target range. Overall, removal of Item 23 did not improve the function of the CISS at the chronic time period and gave no support for dropping items. Although the generally well fitting items suggested that the full CISS may function as a unidimensional measure, the high level residual variance explained in first contrast provided evidence against unidimensionality, thus suggesting that the full CISS with all items functions as a multidimensional measure in this sample.

Reliability

Rasch analyses provide person and item reliability estimates and separation ratios, which supplement understanding of reliability data derived from Cronbach's alpha estimates (Fisher Jr., 1992). CTT treats reliabilities as properties of tests without formally acknowledging that test reliabilities reflect both the construction of the test and the sample on which the reliability was evaluated (e.g., the distribution of persons on the construct assessed by the test). *Person reliability* (a.k.a. person separation reliability) reflects how well person ordering could be replicated using a parallel set of items measuring the construct (Bond & Fox, 2007); high person reliability implies that the measure is able to distinguish among persons with variable levels of ability and to infer consistently what persons sore higher and what persons score lower on the construct of interest (Bond & Fox, 2007). Person reliability in Rasch analysis is analogous to Cronbach's alpha reliability in CTT. *Item reliability*, which is unique to Rasch analysis, reflects how well item ordering could be replicated in other similar samples (Bond & Fox, 2007); high item reliability means that the measure is able to distinguish items of variable difficulty creating an item hierarchy and to discriminate consistently what items are high difficulty and what items are low difficulty (Bond & Fox, 2007). According to (Fisher, 2007), person and item reliability estimates are categorized as poor (< .67), fair (.67 – .80), good (.81 – .90), very good (.91 – .94), or excellent (>

.94) (Fisher, 2007).

The spread of persons or items also can be described using separation ratios, which are expressed in the metric of test error (root mean square error, RMSE). The *person separation index (*or *item separation index)* reflects a ratio of true standard deviation for person (or item) to error standard deviation (RMSE), which statistically parallels the Fisher Discriminant Ratio. Within the spread of persons or items, there are *discernable strata*, which reflect the number of distinct levels measurable. Within a given measure, there are about 4 true standard deviations, which should be increased by 1 RMSE to account for measurement error in the observations. Therefore, significant differences between measures are determined by 3 RMSE. Person and item separation ratios are categorized as poor (< 2), fair (2 – 3), good (3 – 4), very good (4 – 5), or excellent (> 5(Fisher, 2007).

The person and item reliability and separation ratio data for the full CISS at the chronic time period are shown in Table 11. For these analyses, the person separation ratio was 2.83, with person reliability of .89, which is good reliability but relatively weaker person separation. The item separation ratio was 6.82, with item reliability of .98, both of which are excellent.

Targeting

Targeting refers to matching of item difficulty to participant ability. The Rasch analysis Item-Person Map produced in Winsteps, also called the Wright Map, facilitates assessment of how well item difficulty targets person ability for a specific measure used with a specific sample. On these maps (e.g., Figure 2), the vertical axis represents the spread of item difficulty and person ability with high values plotted near the top and low values plotted near the bottom. Items closer to the top are more difficult than items near the bottom and persons closer to the top have more ability (stronger endorsement) in regards to the construct assessed than persons near the bottom.

On the map, items are plotted by difficulty on a logit scale, which are the raw scores converted to a scale with interval properties; persons are plotted by symbols that represent either 4 persons (#) or 1 to 3 persons (.).The symbols M, S, and T denote the mean (M), 1 standard deviation (S) and 2 standard deviations (T) from the mean for persons (left side of the midline) and items (right side of the midline). “Ability” is reflected from most to least: Cases with the highest scores (at the top of the map) most easily endorsed *(agreed with or performed correctly)* the items. Similarly, “difficulty” is presented from most to least: Items with the highest scores (top of the map) were *most difficult to endorse*.

Good targeting of difficulty and ability ideally results in a symmetrical spread of items and persons along the vertical axis of the item person map in Winsteps. According to Baghaei (2008), to obtain “uniformly precise measurement,” the items should cover a wide difficulty range, such that the item difficulties are spaced consistently, there are few gaps between items, and item difficulty levels correspond to person ability levels (Baghaei, 2008). When gaps appear between items or item difficulty levels do not match person ability levels on the item-person map, the measure under-represents the construct (Baghaei, 2008). When item gaps are small or item difficulties correspond well to person abilities, then person ability estimates are more precise, whereas poor item person matching suggests less precise estimation of person ability, often referred to as poor item-person targeting.

Targeting of item difficulty to participant sample ability also is assessed using precise indicators of floor or ceiling effects based on sample distribution across the range of possible raw scores. According to McHorney and Tarlov (1995), the scores obtained by a sample of participants should span the range of possible scores on the scale, with the sample mean approximating the midpoint of the scale and with less than 15% of the sample obtaining the highest or lowest possible

scores. In the case that a greater percentage of the sample obtains the highest or lowest possible scores on the scale, these data would provide clear evidence of ceiling or floor effects, respectively. These frequency data in conjunction with visual examination of the item-person map provided in Winsteps are used to make a judgment regarding the targeting of item difficulty to person ability in a respective sample using a specific measure.

The Item-Person Map for the full CISS at the chronic time period is shown in Figure 2.Visual examination showed that items and persons were distributed rather evenly along the vertical axis, suggesting no major problems with targeting of items within this sample. However, the items appeared to represent a relatively narrow range of difficulty, and so by design, this measure might not capture a great deal of variance. Yet, with this relatively homogenous group of individuals, the limited range of difficulty is not problematic. Additionally, frequency data indicated that there were no problems with floor or ceiling effects in this sample given that less than 15% of the sample obtained the highest or lowest possible scores (McHorney & Tarlov, 1995).

Response Categories

According to (Linacre, 1999), persons with increasing ability should have greater probability of performing at higher levels on increasingly difficult items compared to persons with decreasing ability. Therefore, *category ordering principles* in Rasch analysis expect that as the category difficulty increases across the measure, the average ability associated with that category will increase as well, which means that category average ability should increase monotonically. *Category disordering* occurs when data depart from this expected pattern across categories for particular items. Category disordering overall was assessed in all Rasch analyses for this study by examining the observed averages depicted in Table 3.2 of Winsteps output, which are the “mean of measures in category.” Item-level category disordering was assessed in these Rasch analyses by

examining data from Table 2.6 of Winsteps output, which graphically depict the category response options in increasing numerical sequence of observed averages for each category per item of the scale (expected progression = 12345).

For the full CISS at the chronic time period, the categories increased monotonically, so there was no evidence of category disordering overall; i.e., category 1 (-.52), category 2 (-.22), category 3 (.01), category 4 (.18), category 5 (.35). However, at an item level there was some category disordering with the following items departing from the expected progression (12345): Item 12 (12435), Item 42 (13245), Item 43 (13245), and Item 48 (12354). To determine factors that may be driving the disorder, count data, fit statistics, and category disordering were examined for items in question. Overall, there were five items (6, 9, 23, 27, 47) with low count data (fewer than 10 responses per category per item), but there were no consistent trends across these data to indicate need for collapsing categories. For instance, Category 1 ("*not at all*") had two items with low count data, Category 2 ("*very little*") had one item, Category 3 ("*somewhat*") had zero items, Category 4 ("*quite a bit*") had two items, and Category 5 ("*very much*") had one item. Also, the slightly disordered items did not have serious problems with fit statistics. Overall, the evidence did not lend support for dropping any items.

Threshold disordering is also of importance for assessing the functioning of response categories. Linacre (1999) describes threshold disordering as when the probability of endorsing a particular category does not increase monotonically as expected relative to the difficulty of the category. For all Rasch analyses in this study, threshold disordering was assessed by examining the Andrich thresholds (a.k.a. step thresholds) data depicted in Table 3.2 of Winsteps output. Andrich thresholds are Rasch rating scale structure parameters that reflect probability of observing a category, and are also called Taus, Deltas, and step calibrations; these values reflect the difficulty

in observing a category (i.e., rarity of occurrence, not the difficulty of performing it). In the absence of threshold disordering, Andrich thresholds should increase at each sequentially higher threshold; for example, the value of the Category 4 and 5 threshold should be greater than the value of the Category 3 and 4 threshold. Each threshold value represent an absolute value for the probabilities of observing the categories examined; therefore, the desired monotonic progression of threshold values should increase at each sequential threshold, such that the value of the threshold between Categories 1 and 2 should be smaller than the value of the threshold between Categories 2 and 3 and so on with each sequential threshold value.

For the full CISS at the chronic time period, the Andrich thresholds did not increase as expected, as shown in Figure 3, suggesting that participants had difficulty differentiating among the category options. In this case, the Andrich thresholds increased between sequential categories as .44 (Category 1 and 2), -.69 (Category 2 and 3), .28 (Category 3 and 4), and -.03 (Category 4 and 5). The threshold values for Category 2 and 3 (-.69) is greater than the value for Category 1 and 2 (.44) and the threshold for Category 3 and 4 (.28) is greater than the value for Category 4 and 5 (-.03), which violate the expectation for values to increase monotonically and provide evidence of threshold disordering.

These data suggest that individuals in this sample had difficulty differentiating among the response categories. However, given that there were no problems with fit statistics or category disordering overall, no further action was warranted to address threshold disordering.

Rasch Analysis of CISS: Chronic (Years 5, 10, 15), Task scale

Unidimensionality and Model Fit

The infit and outfit mean-square values for the 16 items on the CISS Task-oriented coping scale are shown in Table 8. Additional diagnostic data for these Rasch analyses are shown in Table

11. For the Task scale at the chronic time period, all items showed good fit with the model based on infit and outfit mean-square values except for Item 1, which showed slight misfit with an infit mean-square value of 1.39 and outfit mean-square value of 1.45 (Table 8). For this scale, there were no problems with negative or weak correlations between items and measure, with correlation values ranging between .51 (Item 6) and .64 (Item 41).

For the Task scale at the chronic time period, the first factor representing the Rasch model accounted for 41.3% of the variance in the measure, which although well below the acceptable range, this value approximated the modeled value of 42.2% (Table 11). For this scale, the unexplained variance explained in the first contrast was 1.9, which is below the desirable maximum value of 3. With the removal of misfitting Item 1, the raw variance explained by the measure only improved to 42.0% and the variance explained in the first contrast did not change, lending no support for dropping items. Overall, the generally acceptable fitting items on the CISS Task-oriented coping scale and the desirable level of unexplained variance in first contrast provide evidence for unidimensionality of the Task-oriented coping scale in this sample.

Reliability

The person and item reliability and separation ratio data for the Task scale at the chronic time period are shown in Table 11. For this measure, the person separation ratio was 2.24, with person reliability of .83, which is good reliability but relatively weaker person separation. The item separation ratio was 3.96, with item reliability of .94, which is considered very good reliability and good item separation.

Targeting

The Item-Person Map for the Task scale at the chronic time period is shown in Figure 4. Visual examination of this map showed that the distribution of person ability was skewed, such

that there were more persons who reported high levels of Task coping ability than there were persons who reported low levels of Task coping ability. This map also showed that the distribution of item difficulty was constrained around the average level of difficulty. Therefore, the Task scale items did not appear to assess adequately the full range of person ability; persons reporting high levels of task coping were not differentiated from those reporting average levels of task coping using these items. Additionally, the limited range of difficulty captured by these items suggested that in the chronic time period after TBI, the Task scale by design might not capture a meaningful amount of variance. Note, however, that frequency data supplied no evidence of clear ceiling or floor effects in this sample as less than 15% of the sample obtained the highest or lowest possible scores.

Response Categories

For the Task scale at the chronic time, the categories increased monotonically, so there was no evidence of category disordering overall; i.e., Category 1 (-.48), Category 2 (-.19), Category 3 (.18), Category 4 (.67), Category 5 (1.30). At an item level for this measure there was slight category disordering for items 26 (21345). To determine factors that may be driving the disordering, count data, fit statistics, and category disordering were examined for Item 26. Overall, there were three items (6, 27, 47) with low count data, but there were no consistent trends across these data to indicate need for collapsing categories. Also, the slightly disordered Item 26 did not have any problems with fit statistics. Overall, there was no reason to drop items or collapse categories.

Looking at threshold disordering for the Task scale at chronic time, the Andrich-thresholds did not increase as expected, suggesting that participants had difficulty differentiating among the category options. In this case, the Andrich thresholds increased between sequential categories as -

.19 (Category 1 and 2), -.98 (Category 2 and 3), .47 (Category 3 and 4), and .69 (Category 4 and 5). These values did not increase monotonically and suggest that participants struggled to differentiate among response categories.

Rasch Analysis of CISS: Chronic (Years 5, 10, 15), Emotion scale

Unidimensionality and Model Fit

The infit and outfit mean-square values for the 16 items on the CISS Emotion-oriented coping scale are shown in Table 9. Additional diagnostic data for these Rasch analyses are shown in Table 11. For this measure, all items showed good fit with the model based on infit and outfit mean-square values except for Item 33, which showed slight misfit with an infit mean-square value of 1.36 and outfit mean-square value of 1.59 (Table 9). For this scale, there were no problems with negative or weak correlations between items and measure, with correlation values ranging between .46 (Item 33) and .66 (Item 38).

The first factor representing the Rasch model accounted for 41.2% of the variance in the measure, which although below the target 60% range, this value approximated the modeled value of 41.8% (Table 11). For this scale, the unexplained With the removal of misfitting Item 33, the raw variance explained by the measure only improved to 42.5% and the variance explained in the first contrast changed to 2.0, lending no support for dropping items. Overall, the generally acceptable fitting items on the CISS Emotion-oriented coping scale and the desirable level of unexplained variance in first contrast suggest that the Emotion-oriented coping scale functions as a unidimensional measure in this sample.

Reliability

The person and item reliability and separation ratio data for the Emotion scale at the chronic time period are shown in Table 11. For this measure, the person separation ratio was 2.13, with

person reliability of .82, which is considered good reliability but relatively weaker person separation. The item separation ratio was 5.13, with item reliability of .96, both of which are considered excellent values.

Targeting

The Item-Person Map for the Emotion scale at the chronic time period is shown in Figure 5. Visual examination of this map showed that the distribution of person ability was skewed, such that there were more persons who reported lower levels of Emotion coping than there were persons who reported higher levels of Emotion coping. This map also showed that the spread of item difficulty reflected well the person ability distribution in the average range of emotion coping but that the items did not capture the more extreme high and low levels of emotion coping ability represented in this sample of participants. Overall, the Emotion scale items appeared to not adequately assess the full range of variance in emotion coping. Using this scale, persons in this sample with extreme high and low levels of emotion coping were not well differentiated from those with emotion coping levels in the moderate range. As shown with the CISS full measure and Task scale results, the Emotion scale by design did not appear to capture a meaningful amount of variance. However, there was no clear evidence for ceiling or floor effects based on frequency data at the extreme scores for this sample.

Response Categories

For the Emotion scale at the chronic time, the categories increased monotonically, so there was no evidence of category disordering overall; i.e., Category 1 (-.81), Category 2 (-.42), Category 3 (-.10), Category 4 (.21), Category 5 (.47). At an item level for this measure there was no category disordering. These data suggest that higher average emotion coping ability corresponded with higher category rating in this sample (Linacre, 1999). Overall, no items on the

Emotion scale at chronic time had low count data. Taken together, the count data and fit statistics indicated no need to drop items for the Emotion scale at chronic time.

Looking at threshold disordering for the Emotion scale at chronic time, the Andrich-thresholds did not increase as expected, suggesting that participants had difficulty differentiating among the category options. In this case, the Andrich thresholds increased between sequential categories as .21 (Category 1 and 2), -.66 (Category 2 and 3), .36 (Category 3 and 4), and .09 (Category 4 and 5).

Rasch Analysis of CISS: Chronic (Years 5, 10, 15), Avoidance scale

Unidimensionality and Model Fit

The infit and outfit mean-square values for the 16 items on the CISS Avoidance coping scale are shown in Table 10. Additional diagnostic data for these Rasch analyses are shown in Table 11. All items showed good fit with the model based on infit and outfit mean-square values, indicating that all 16 items had excellent fit for the Avoidance scale.

Correlations among items and measure were examined by looking at the Item Statistics table (Table 10.1) in Winsteps output. For this scale, there were no problems with negative or weak correlations between items and measure, with correlation values ranging between .37 (Item 23) and .58 (Item 12).

The first factor representing the Rasch model accounted for 37.6% of the variance in the measure, which although below the target 60% range, this value approximated the modeled value of 38.1% (Table 11). Additionally, the unexplained variance explained in the first contrast was 2.5, which was below the desirable maximum value of 3. Overall, the excellent fitting items on the CISS Avoidance scale and the desirable level of residual variance in the first contrast suggested that the Avoidance scale functions as a unidimensional measure in this sample.

Reliability

The person and item reliability and separation ratio data for the Avoidance scale at the chronic time period are shown in Table 11. For this measure, the person separation ratio was 1.81, with person reliability of .77, which is considered fair reliability and poor person separation. The item separation ratio was 6.74, with item reliability of .98, both of which are considered excellent values.

Targeting

The Item-Person Map for the Avoidance scale at the chronic time period is shown in Figure 6. Visual examination of this map showed that the distribution of person ability was slightly skewed, such that there were slightly more persons who reported lower levels of Avoidance coping than there were persons who reported higher levels of Avoidance coping. This map also showed that the distribution of item difficulty fully captured the upper range of person ability but did not fully capture the lower range of person ability for avoidance coping. In other words, persons with the lowest level of avoidance coping were not differentiated well using this scale from persons with moderate levels of avoidance coping. Therefore, within this sample, the Avoidance scale did not appear to capture a meaningful amount of variance of avoidance coping ability. Note that frequency data did not indicate clear ceiling or floor effects as few people in this sample scored at the extreme ranges on this measure.

Response Categories

For the Avoidance scale at the chronic time, the categories increased monotonically, so there was no evidence of category disordering overall; i.e., Category 1 (-.75), Category 2 (-.36), Category 3 (-.13), Category 4 (.09), Category 5 (.25). Levels of avoidance coping increased with category ratings in this sample. At an item level for this measure there was slight category

disordering for Item 48 (12354). To determine factors that may be driving the disorder, count data, fit statistics, and category disordering were examined for Item 48. Overall, there were two items with low count data (9, 23), but these items did not have any problems with fit statistics. Based on these data, there was no strong reason to drop items or collapse categories at this time.

Looking at threshold disordering for the Avoidance scale at chronic time, the Andrich-thresholds did not increase as expected, suggesting that participants had difficulty differentiating among the category options. In this case, the Andrich thresholds increased between sequential categories as .43 (Category 1 and 2), -.56 (Category 2 and 3), .27 (Category 3 and 4), and -.14 (Category 4 and 5).

Rasch Analysis of CISS: Year 1, All Items

Unidimensionality and Model Fit

The infit and outfit mean-square values for the 48 items on the CISS are shown in Table 7. Additional diagnostic data for these Rasch analyses are shown in Table 11. Most items showed good fit with the model based on infit and outfit mean-square values except for Items 4, 6, 9, 23, 43, and 45, which showed misfitting infit mean-square values between 0.64 and 1.81 and outfit mean-square values between 0.66 and 1.91 (Table 7). For this scale, there were no problems with negative or weak correlations between items and measure, with correlation values ranging between .15 (Item 6) and .52 (Items 18 and 37).

The first factor representing the Rasch model accounted for 31.9% of the variance in the measure, which although below the target 60% range, this value approximated the modeled value of 32.4% (Table 11). The unexplained variance in first contrast was 8.3, which exceeded the desirable maximum value of 3.

In order to determine if the CISS might function better as a measure with the deletion of

misfitting items, Rasch analysis was repeated for Year 1 after dropping items 4, 6, 9, 23, 43, and 45. With these dropped items, the model accounted for 31.0% of the variance in the measure, which falls below the desired 60% level and falls below the modeled value of 31.6%, and the variance explained in first contrast was 7.3. Taken together, these data suggest that the CISS as one measure did not improve in function with the deletion of items that did not fit perfectly well. Therefore, there was no strong reason to drop items.

Overall, these data suggest that most items in the full CISS measure fit well and those items with slight misfit still contributed positively to the overall function of the measure. In regards to dimensionality, the high level of variance explained in the first contrast was inconsistent with expectations for a unidimensional model, which suggested that the CISS at 1 year after TBI likely functions as a multidimensional measure.

Reliability

The person and item reliability and separation ratio data for the full CISS at Year 1 are shown in Table 11. For this measure, the person separation ratio was 2.89, with person reliability of .89, which is considered good reliability and fair person separation. The item separation ratio was 4.53, with item reliability of .95, which is considered excellent reliability and very good item separation.

Targeting

The Item-Person Map for the full CISS at Year 1 is shown in Figure 7. Visual examination of this map showed that the distribution of person ability formed a relatively narrow band around the average level of ability. The distribution of item difficulty reflected a similarly narrow band around the average difficulty level. Therefore, although these items only captured a narrow range of overall coping ability, the measure adequately captured the variance represented in this rather

homogenous participant group. However, in general, the measure did not appear to be designed in such a manner as to capture a wide range of variance in coping style. Additional consideration of frequency data indicated no problems with ceiling or floor effects in this sample.

Response Categories

For the full CISS at Year 1, the categories increased monotonically, so there was no evidence of category disordering overall; i.e., category 1 (-.56), category 2 (-.22), category 3 (-.02), category 4 (.21), category 5 (.43). At an item level for this measure there was slight category disordering for Item 7 (12435), Item 9 (12435), Item 41 (13245), and Item 47 (13245). To determine factors that may be driving the disorder, count data, fit statistics, and category disordering were examined for these items. Overall, 22 of the 48 items had low count data (i.e., items 2, 3, 6, 9, 15, 18, 20, 21, 23, 24, 25, 26, 27, 28, 35, 39, 40, 41, 42, 43, 45, 47). Across these items, each category had the following number of items total with low count data: Category 1 (12 items), Category 2 (13 items), Category 3 (1 item), Category 4 (5 items), Category 5 (4 items). These data suggested that low count data may have accounted for the category disordering in items 9, 41, and 47. Of the four disordered items, only Item 9 had problems with fit statistics. Given the prevalence and trends in low count data and the lack of clear evidence of poor fit for disordered items, there was no strong reason to drop specific items. However, these data suggested that the measure might benefit from collapsing Categories 1 and 2 given the consistent trend in low count data for these categories at Year 1 in this sample; however category function and consideration of collapsing categories must be considered in regard to utility across all time points as used in this study.

Looking at threshold disordering for the CISS at Year 1, the Andrich-thresholds did not increase as expected, suggesting that participants had difficulty differentiating among the category

options. In this case, the Andrich thresholds increased between sequential categories as .15 (Category 1 and 2), -.73 (Category 2 and 3), .20 (Category 3 and 4), and .38 (Category 4 and 5). These values did not increase monotonically and suggested that participants had particular difficulty differentiating among categories. Threshold disordering might account, in part, for some of the category disordering described above.

Rasch Analysis of CISS: Year 1, Task scale

Unidimensionality and Model Fit

The infit and outfit mean-square values for the 16 items on Task scale are shown in Table 8. Additional diagnostic data for these Rasch analyses are shown in Table 11. Most items showed good fit with the model based on infit and outfit mean-square values except for Items 6, 43, and 46, which showed misfitting infit mean-square values between 0.68 and 2.03 and outfit mean-square values between 0.77 and 1.92 (Table 8). For this scale, there were no problems with negative or weak correlations between items and measure, with correlation values ranging between .35 (Item 6) and .68 (Item 26).

The first factor representing the Rasch model accounted for 43.2% of the variance in the measure, which although below the target 60% range, this value approximated the modeled value of 44.1% (Table 11). The unexplained variance explained in the first contrast was 2.2, which fell below the desirable maximum value of 3 and suggested that the Task scale at Year 1 was unidimensional.

In order to determine whether the Task scale might function better as a measure with the deletion of misfitting items, Rasch analysis was repeated for Year 1 after dropping Items 6, 43, and 46. With these dropped items, the model accounted for 46.2% of the variance in the measure, which fell below the desired 60% level and fell below the modeled value of 47.1%, and the

unexplained variance in first contrast was 2.1. Although dropping these items improved the amount of variance explained in the measure, the total value still was below expectations for good measurement. Taken together, these data suggested that the Task scale did not meaningfully improve in function with the deletion of items that did not fit perfectly well. Therefore, there was no strong reason to drop items.

Overall, these data suggested that most items in the Task scale fit well and removal of those items with slight misfit did not greatly improve the overall function of the measure. In regards to dimensionality, the low level of variance explained in the first contrast was consistent with expectations of a unidimensional measure.

Reliability

The person and item reliability and separation ratio data for the Task scale at Year 1 are shown in Table 11. For this measure, the person separation ratio was 2.42 with person reliability of .85, which is good reliability and fair person separation. The item separation ratio was 3.14, with item reliability of .91, which is very good reliability and good item separation.

Targeting

The Item-Person Map for the Task scale at Year 1 is shown in Figure 8. Visual examination of this map showed that the distribution of person ability was relatively skewed, such that there were more persons with extremely high levels of task coping ability than there were persons with extremely low levels of task coping ability. In contrast to the relative spread of person ability, the distribution of item difficulty was relatively constricted around the moderate or average range of task coping. Consequently, these items did not capture the variance in person ability at either extreme end of spectrum. In particular, these items did a poor job of differentiating persons with very high levels of task coping ability from persons with moderately high levels of task coping

ability. Overall, these items did not adequately target the range of task coping ability represented in this sample and in general did not capture a wide range of variance in task coping. However, frequency data did not provide evidence of clear ceiling or floor effects as few persons in the sample obtained the highest or lowest scores.

Response Categories

For the Task scale at Year 1, the categories increased monotonically, so there was no evidence of category disordering overall; i.e., category 1 (-.70), category 2 (-.32), category 3 (.16), category 4 (.68), category 5 (1.39). Levels of task coping increased with higher category ratings in this sample. At an item level for this measure there was slight category disordering for Item 2 (21345), Item 6 (21345), and Item 46 (13245). To determine factors that may be driving the disorder, count data, fit statistics, and category disordering were examined for these items. Overall, 12 of the 16 items had low count data (i.e., Items 2, 6, 15, 21, 24, 26, 27, 39, 41, 42, 43, and 47). Across these items, all low count data were for Category 1 (9 items) or Category 2 (10 items). These data suggest that low count data may have accounted for the category disordering in Items 2 and 6. Of the three disordered items, Items 6 and 46 had problems with fit statistics. Given the trends in count data, low count data may have accounted for the item level category disordering. However, the misfit in disordered Items 6 and 46 also suggested that these items might have been a poor fit for the scale irrespective of category functioning. To test this possibility, the analysis was rerun without Items 6 and 46; however, deletion of these items did not improve the functioning of the measure in any of the domains discussed and actually lowered the amount of variance explained in the measure to 12.3%. Overall, these data suggested that the Task scale might benefit from collapsing Categories 1 and 2 given the consistent trend in low count data for these categories at Year 1 in this sample.

Looking at threshold disordering for the Task scale at Year 1, the Andrich thresholds did not increase as expected, suggesting that participants had difficulty differentiating among the category options. In this case, the Andrich thresholds increased between sequential Categories as -.42 (Category 1 and 2), -1.09 (Category 2 and 3), .21 (Category 3 and 4), and 1.30 (Category 4 and 5). Threshold disordering might have accounted, in part, for the category disordering described above.

Rasch Analysis of CISS: Year 1, Emotion scale

Unidimensionality and Model Fit

The infit and outfit mean-square values for the 16 items on Emotion scale are shown in Table 9. Additional diagnostic data for these Rasch analyses are shown in Table 11. Most items showed good fit with the model based on infit and outfit mean-square values except for Items 19 and 45, which showed misfitting infit mean-square values between 0.60 and 1.60 and outfit mean-square values between 0.57 and 1.81 (Table 9). For this scale, there were no problems with negative or weak correlations between items and measure, with correlation values ranging between .43 (Item 28) and .69 (Item 19).

The first factor representing the Rasch model accounted for 41.9% of the variance in the measure, which although below the target 60% range, this value approximated the modeled value of 42.4% (Table 11). The unexplained variance explained in the first contrast was 2.2, which was below the desirable maximum value of 3.

In order to determine if the Emotion scale might function better as a measure with the deletion of misfitting items, Rasch analysis was repeated for Year 1 after dropping Items 19 and 45. With these dropped items, the model accounted for 39.8 % of the variance in the measure, which was below the desired 60% level and the modeled variance of 40.3%, and the unexplained

variance in first contrast was 2.1. Taken together, these data suggested that the Emotion scale did not improve in function with the deletion of items that did not fit perfectly well. Therefore, there was no strong reason to drop items.

Overall, these data suggested that most items in the Emotion scale fit well and those items with slight misfit still contributed positively to the overall function of the measure. In regards to dimensionality, the low level of variance explained in the first contrast was consistent with expectations of a unidimensional measure.

Reliability

The person and item reliability and separation ratio data for the Emotion scale in Year 1 are shown in Table 11. For this measure, the person separation ratio was 2.15 with person reliability of .82, which is good reliability and fair person separation. The item separation ratio was 3.94, with item reliability of .94, which is very good reliability and good item separation.

Targeting

The Item-Person Map for the Emotion scale at Year 1 is shown in Figure 9. Visual examination of this map showed that the distribution of person ability was fairly normally distributed in this sample, such that most persons were in the average range whereas a few persons were in the high and low ranges of ability. Conversely, item difficulty was not well distributed across the full range of emotion coping and appeared to capture variance only within the moderate range; also, item difficulty appeared to target only a few levels of emotion coping rather than a continuum of emotion coping, even within the average or moderate range. Overall, these items appeared to do a poor job targeting the full range of emotion coping represented in this sample. Item difficulties poorly estimated persons with high and low levels of emotion coping as shown by the clusters of person symbols (e.g., XX) on both of the high and low ends of the map that were

not matched with items of corresponding difficulty levels. However, consideration of frequency data gave no support for clear ceiling or floor effects given that fewer than 15% of the sample obtained the highest or lowest possible scores.

Response Categories

For the Emotion scale at Year 1, the categories increase monotonically, so there was no evidence of category disordering overall; i.e., Category 1 (-.78), Category 2 (-.45), Category 3 (-.10), Category 4 (.19), Category 5 (.66). Levels of emotion coping increased with category ratings in this sample. At an item level, there was slight category disordering for Item 16 (12435). To determine factors that may be driving the disorder, count data, fit statistics, and category disordering were examined for this item. Overall, 3 of the 16 items had low count data (25, 28, and 45) and there were no consistent trends for low count categories. Item fit statistics for Item 16 were not problematic. Taken together, there was no strong evidence for dropping Item 16 or for altering categories.

Looking at *threshold disordering* for the Emotion scale at Year 1, the Andrich-thresholds did not increase as expected, suggesting that participants had difficulty differentiating among the category options. In this case, the Andrich thresholds increased between sequential categories as -.18 (category 1 and 2), -.57 (category 2 and 3), .46 (category 3 and 4), and .29 (category 4 and 5).

Rasch Analysis of CISS: Year 1, Avoidance scale

Unidimensionality and Model Fit

The infit and outfit mean-square values for the 16 items on the CISS Avoidance scale are shown in Table 10. Additional diagnostic data for these Rasch analyses are shown in Table 11. Many items showed good fit with the model based on infit and outfit mean-square values. However, Items 4, 9, 18, 23, and 37 were somewhat misfitting for the scale with misfitting infit

mean-square values between 0.65 and 1.45 and outfit mean-square values between 0.60 and 1.68. For this scale, there were no problems with negative or weak correlations between items and measure, with correlation values ranging between .42 (Item 35) and .70 (Item 18). The first factor representing the Rasch model accounted for 43.4% of the variance in the measure, which although below the target 60% range, this value approximated the modeled value of 43.9% (Table 11). The variance explained in first contrast was 2.5, which was below the desirable maximum value of 3.

In order to determine if the Avoidance scale might function better as a measure with the deletion of misfitting items, Rasch analysis was repeated for Year 1 after dropping Items 4, 9, 18, 23, and 37. With these dropped items, the model accounted for 41.7% of the variance in the measure, which was below the desired 60% level and below the modeled 42.1%, and the unexplained variance in first contrast was 2.1. Taken together, these data suggest that the Avoidance scale did not improve in function with the deletion of items that did not fit perfectly well. Therefore, there was no strong reason to drop items.

Overall, these data suggested that most items in the Avoidance scale fit well and those items with some misfit still contributed positively to the overall function of the measure. In regards to dimensionality, the low level of unexplained variance in the first contrast was consistent with expectations of a unidimensional measure.

Reliability

The person and item reliability and separation ratio data for the Avoidance scale in Year 1 are shown in Table 11. For this measure, the person separation ratio was 2.25 with person reliability of .83, which is good reliability and fair person separation. The item separation ratio was 4.73, with item reliability of .96, which is excellent reliability and very good item separation.

Targeting

The Item-Person Map for the Avoidance scale at Year 1 is shown in Figure 10. Visual examination of this map showed that the distribution of person ability was fairly normally distributed in this sample, such that most persons were in the average range while a few persons were in both the high and low ranges of ability. However, item difficulty was poorly distributed in that items did not capture the full range of avoidance coping. Item difficulty targeted primarily the moderate range of avoidance coping and within this range items did not appear to differentiate well persons with varied levels of ability. In other words, these items appeared to target only a few levels of moderate avoidance coping rather than targeting different levels of avoidance coping across the full range of average ability, let alone across the full range of ability in general. Overall, the items of the Avoidance scale poorly targeted variability in coping. However, frequency data did not provide evidence of ceiling or floor effects as few persons in the sample obtained the highest or lowest possible scores.

Response Categories

For the Avoidance scale at Year 1, the categories increased monotonically, so there was no evidence of category disordering overall; i.e., category 1 (-.94), category 2 (-.41), category 3 (-.15), category 4 (.24), category 5 (.51). Levels of avoidance coping increased with higher category ratings in this sample. At an item level for this measure there was slight category disordering for Item 9 (12435) and Item 44 (13245). To determine factors that may be driving the disorder, count data, fit statistics, and category disordering were examined for these items. Overall, 7 of the 16 items had low count data (i.e., items 3, 9, 18, 20, 23, 35, 40) and there were no consistent trends for low count categories. Item fit statistics were not problematic for Items 3, 20, 35, or 40, but Items 9, 18, and 23 were slightly misfitting. However, deletion of the misfitting items did not improve the scale function, as described above. Therefore, there was no strong reason at the time

to drop slightly disordered items or to alter categories.

Looking at threshold disordering for the Avoidance scale at Year 1, the Andrich thresholds did not increase as expected, suggesting that participants had difficulty differentiating among the category options. In this case, the Andrich thresholds increased between sequential categories as .12 (Category 1 and 2), -.83 (Category 2 and 3), .35 (Category 3 and 4), and .37 (Category 4 and 5).

Rasch Analysis of CISS: Year 2, All Items

Unidimensionality and Model Fit

The infit and outfit mean-square values for the 48 items on the CISS are shown in Table 7. Additional diagnostic data for these Rasch analyses are shown in Table 11. Many items showed good fit with the model based on infit and outfit mean-square values; however, nine items (7, 8, 13, 23, 27, 39, 41, 45, 47, 48) showed misfit, with infit mean-square values between 0.60 and 1.43 and outfit mean-square values between 0.61 and 1.80 (Table 7). For this scale, there were no problems with negative correlations between items and measure, with correlation values ranging between .08 (Item 25) and .59 (Item 27). However, some of these items (7, 13, 25, 45) had relatively weak correlations with the measure, with correlations as low as .08.

The first factor representing the Rasch model accounted for 32.3% of the variance in the measure, which although below the target 60% range, this value maximized the modeled value of 32.3% (Table 11). The unexplained variance in first contrast was 8.3, which exceeded the desirable maximum value of 3 and provided evidence against unidimensionality of the full CISS at Year 2.

In order to determine if the CISS might function better as a measure with the deletion of all possible misfitting items, Rasch analysis was repeated for Year 2 after dropping items with any evidence of misfit (7, 8, 13, 23, 27, 39, 41, 45, 47, 48). With these dropped items, the model

accounted for 31.7% of the variance in the measure, which falls below the desired 60% level and approximates the modeled 31.8%, and the unexplained variance in first contrast was 7.3. Furthermore, of the items with low correlations with the measure, Items 7, 13, and 45 also had problems with fit statistics. Therefore, these analyses were rerun with deletion of only Items 7, 13 and 45 to determine if the measure function might be improved; with these deletions, the amount of variance explained by the measure was 33.0%, which is lower than the ideal value of 60% and approximates the modeled value of 33.1%. Taken together, these data suggested that the full CISS does not improve greatly in function with the deletion of items that do not fit perfectly well. Therefore, there was no strong reason to drop items.

Overall, these data suggested that many items in the full CISS fit well and those items with some misfit still contributed positively to the overall function of the measure. In regards to dimensionality, the high level of unexplained variance in the first contrast was inconsistent with expectations of a unidimensional measure and suggested that the CISS did not function as a unidimensional measure at 2 years after TBI.

Reliability

The person and item reliability and separation ratio data for the full CISS at Year 2 are shown in Table 11. For this measure, the person separation ratio was 2.59 with person reliability of .87, which is good reliability and fair person separation. The item separation ratio was 4.53, with item reliability of .95, which is excellent reliability and very good item separation.

Targeting

The Item-Person Map for the full CISS at Year 2 is shown in Figure 11. Visual examination of this map showed that the distribution of person ability was slightly skewed, such that most persons had moderate or average range coping ability with slightly more persons in the lower

ranges of coping ability than persons in the higher ranges of coping ability. Item distribution appeared constrained around the moderate range of item difficulty and did not capture the full range of coping variance; however, item difficulty targeted most of the variance seen in this sample. Frequency data also indicated that there were no problems with ceiling or floor effects in this sample.

Response Categories

For the full CISS at Year 2, the categories increased monotonically, so there was no evidence of category disordering overall; i.e., Category 1 (-.52), Category 2 (-.28), Category 3 (-.03), Category 4 (.14), Category 5 (.35). Higher levels of coping corresponded with higher category ratings in this sample. At an item level for this measure there was category disordering for the following 13 items: Item 1 (12435), Item 8 (13245), Item 10 (12354), Item 13 (14235), Item 16 (13245), Item 17 (13425), Item 21 (13245), Item 25 (13245), Item 30 (13245), Item 32 (13245), Item 40 (13245), Item 45 (13254), and Item 48 (12435). To determine factors that may be driving the disorder, count data, fit statistics, and category disordering were examined for these items. Overall, 29 of the 48 items had low count data (i.e., Items 2, 6, 7, 9, 11, 13, 15, 18, 20, 21, 22, 23, 24, 25, 26, 27, 28, 34, 35, 37, 39, 40, 41, 42, 43, 45, 46, 47, and 48). All five categories had multiple items with low count data, with Categories 2 and 4 with the most instances of low count data: Category 1 (8 items), Category 2 (15 items), Category 3 (4 items), Category 4 (10 items), Category 5 (7 items). For Items 13, 21, 25, 40, 45, 48 it was possible that low count data contributed to the category disordering described above. Item fit statistics were not problematic for most items with category disordering but were problematic for Items 8, 13, 45, and 48. Therefore, category disordering at an item level likely was not due to problems with item fit overall for most disordered items, and removal of misfitting items as described above did not improve the function of the

measure. Therefore, there was no strong reason to consider dropping items; however, this measure might improve in function if the category structure was altered.

Looking at threshold disordering for the full CISS at Year 2, the Andrich thresholds did not increase as expected, suggesting that participants had difficulty differentiating among the category options. In this case, the Andrich thresholds increased between sequential categories as .17 (Category 1 and 2), -.49 (Category 2 and 3), .23 (Category 3 and 4), and .09 (Category 4 and 5). These values did not increase monotonically and suggested that participants had difficulty differentiating among the five category response options.

Rasch Analysis of CISS: Year 2, Task scale

Unidimensionality and Model Fit

The infit and outfit mean-square values for the 16 items of the Task scale are shown in Table 8. Additional diagnostic data for these Rasch analyses are shown in Table 11. All items showed good fit with the model based on infit and outfit mean-square values except for Items 1 and 6 that were slightly misfitting with infit mean-square values between 1.31 and 1.63 and outfit mean-square values between 1.21 and 1.69 (Table 8). For this scale, there were no problems with negative or weak correlations between items and measure, with correlation values ranging between .51 (Item 1) and .72 (Item 24).

The first factor representing the Rasch model accounted for 48.9% of the variance in the measure, which although below the target 60% range, this value approximated the modeled value of 49.9% (Table 11). The unexplained variance in first contrast was 2, which was below the desirable maximum value of 3.

In order to determine if the Task scale might function better without the slightly misfitting items, Items 1 and 6 were dropped from the scale and the analyses rerun. With deletion of these

two items, the model accounted for 50.3% of the variance in the measure, which was below the desired 60% level and approximated the modeled 50.7%, and the unexplained variance in first contrast was 1.9. These data suggested that the Task scale did not improve greatly to account for a meaningful amount of variance in the measure with deletion of slightly misfitting items. Therefore, there was no strong reason to drop items. In regards to dimensionality, the low level of unexplained variance in the first contrast was consistent with expectations of a unidimensional measure and suggested that the Task scale in this sample was unidimensional.

Reliability

The person and item reliability and separation ratio data for the Task scale in Year 2 are shown in Table 11. For this measure, the person separation ratio was 2.65 with person reliability of .88, which was good reliability and fair person separation. The item separation ratio was 2.63, with item reliability of .87, which was good reliability and fair item separation.

Targeting

The Item-Person Map for the Task scale in Year 2 is shown in Figure 12. Visual examination of this map showed that the distribution of person ability was skewed, such that there were more persons with high levels of task coping ability than there were persons with low levels of task coping ability. Item distribution was normally distributed within the average range of task coping but this distribution did not target the full range of variance of ability at either the high end or low end of ability in this sample. Item difficulty targeting was particularly poor for differentiating persons with high levels of task coping ability. However, frequency data gave no evidence of clear ceiling or floor effects as fewer than 15% of the sample obtained the highest or lowest scores.

Response Categories

For the Task scale at Year 2, the categories increased monotonically, so there was no evidence of category disordering overall; i.e., Category 1 (-.91), Category 2 (-.40), Category 3 (.18), Category 4 (.75), Category 5 (1.50). At an item level for this measure there was no category disordering.

Looking at threshold disordering for the Task scale at Year 2, the Andrich thresholds did not increase as expected, suggesting that participants had difficulty differentiating among the category options. In this case, the Andrich thresholds increased between sequential categories as -.54 (Category 1 and 2), -.90 (Category 2 and 3), .43 (Category 3 and 4), and 1.02 (Category 4 and 5). These values did not increase monotonically and suggested that participants had difficulty differentiating among the five category response options.

Rasch Analysis of CISS: Year 2, Emotion scale

Unidimensionality and Model Fit

The infit and outfit mean-square values for the 16 items of the Emotion scale are shown in Table 9. Additional diagnostic data for these Rasch analyses are shown in Table 11. All items showed good fit with the model based on infit and outfit mean-square values except for Items 5 and 7 that were slightly misfitting with infit mean-square values between 1.36 and 1.39 and outfit mean-square values between 1.36 and 1.42 (Table 9). For this scale, there were no problems with negative or weak correlations between items and measure, with correlation values ranging between .40 (Item 7) and .68 (Item 17).

The first factor representing the Rasch model accounted for 39.0% of the variance in the measure, which although below the target 60% range, this value approximated the modeled value of 39.8% (Table 11). The unexplained variance in first contrast was 2.6, which was below the desirable maximum value of 3.

In order to determine if the Emotion scale might function better without the slightly misfitting items, Items 5 and 7 were dropped from the scale and the analyses rerun. With deletion of these two items, the model accounted for 42.6% of the variance in the measure, which falls below the desired 60% level and below the modeled 43.3%, and the unexplained variance in first contrast was 2.6. These data suggested that the Emotion scale did not improve greatly to account for a meaningful amount of variance in the measure with deletion of slightly misfitting items. Therefore, there was no strong reason to drop items. In regards to dimensionality, the low level of unexplained variance in the first contrast was consistent with expectations of unidimensionality and suggested that the Emotion scale in this sample was unidimensional.

Reliability

The person and item reliability and separation ratio data for the Emotion scale at Year 2 are shown in Table 11. For this measure, the person separation ratio was 2.11 with person reliability of .82, which is good reliability and fair person separation. The item separation ratio was 3.45, with item reliability of .94, which is very good reliability and good item separation.

Targeting

The Item-Person Map for the Emotion scale for Year 2 is shown in Figure 13. Visual examination of this map showed that the distribution of person ability was skewed, such that there were more persons reporting low levels of emotion coping than there were persons reporting high levels of emotion coping. It is important to note that these and other Rasch data descriptions of ‘high’ or ‘low’ levels of coping reflect within group interpretations for this sample based on the range of values possible for the respective CISS scales. Conversely, normative data allow for interpretations of this sample’s obtained scores relative to an external standard based on scores from a healthy sample. Therefore, it is necessary to consider obtained scores in the context of

within group interpretations relative to the values possible on the scales and in the context of between group interpretations relative to the external normative standard. At Year 2, for example, persons often scored at the low end of the emotion-oriented coping scale more so than at the high end of this scale; however, relative to the external standard, persons in this TBI sample reported *greater* amounts of emotion coping (z = +0.35) compared to healthy persons in the normative sample.

For Year 2 emotion coping, item distribution was normally distributed within the average range of emotion coping but this distribution did not target the full range of variance of ability at either the high end or low end of ability in this sample. Item difficulty targeting was particularly poor for differentiating persons reporting low levels of emotion coping. However, frequency data did not provide evidence for ceiling or floor effects in this sample as few persons obtained the highest or lowest scores possible.

Response Categories

For the Emotion scale at Year 2, the categories increased monotonically, so there was no evidence of category disordering overall; i.e., category 1 (-.83), category 2 (-.45), category 3 (-.14), category 4 (.11), category 5 (.47). At an item level for this measure there was slight category disordering for Item 8 (13245). To determine factors that may be driving the disorder in Item 8, count data and fit statistics were examined, which showed no low count data or problems with fit statistics for this item.

Looking at threshold disordering for the Emotion scale at Year 2, the Andrich thresholds did not increase as expected, suggesting that participants had difficulty differentiating among the category options. In this case, the Andrich thresholds increased between sequential categories as -.19 (Category 1 and 2), -.40 (Category 2 and 3), .47 (Category 3 and 4), and .12 (Category 4 and

5).

Rasch Analysis of CISS: Year 2, Avoidance scale

Unidimensionality and Model Fit

The infit and outfit mean-square values for the 16 items of the Avoidance scale are shown in Table 10. Additional diagnostic data for these Rasch analyses are shown in Table 11. For this measure, all items showed good fit with the model based on infit and outfit mean-square values except for Item 48 that had an infit mean-square of 1.57 and outfit mean-square of 2.10. For this scale, there were no problems with negative or weak correlations between items and measure, with correlation values ranging between .38 (Item 48) and .63 (Item 12).

The first factor representing the Rasch model accounted for 44.0% of the variance in the measure, which although below the target 60% range, this value approximated the modeled value of 44.8% (Table 11). The unexplained variance in first contrast was 2.7, which was below the desirable maximum value of 3.

In order to determine if the Avoidance scale might function better without the slightly misfitting item, Item 48 was dropped from the scale and the analyses rerun. With deletion of this item, the model accounted for 47.0% of the variance in the measure, which was below the desired 60% level and below the modeled 47.8%, and the unexplained variance in first contrast was 2.6. These data suggest that the Avoidance scale did not improve greatly to account for a meaningful amount of variance in the measure with deletion of a slightly misfitting item. Therefore, there was no strong reason to drop items. In regards to dimensionality, the low level of unexplained variance in the first contrast was consistent with expectations of a unidimensional measure and suggested that the Avoidance scale in this sample was unidimensional.

Reliability

The person and item reliability and separation ratio data for the Avoidance scale in Year 2 are shown in Table 11. For this measure, the person separation ratio was 2.1 with person reliability of .81, which is good reliability and fair person separation. The item separation ratio was 4.59, with item reliability of .95, which is excellent reliability and very good item separation.

Targeting

The Item-Person Map for the Avoidance scale in Year 2 is shown in Figure 14. Visual examination of this map showed that the distribution of person ability was slightly skewed, such that there were more persons with low levels of avoidance coping ability than there were persons with high levels of avoidance coping ability. Item distribution was normally distributed within the average range of avoidance coping but this distribution did not target the full range of variance of ability at either the high end or low end of ability in this sample. Item difficulty targeting was particularly poor for differentiating persons with low levels of avoidance coping ability. However, frequency data gave no support for ceiling or floor effects as few persons obtained the most extreme scores possible.

Response Categories

For the Avoidance scale at Year 2, the categories increased monotonically, so there was no evidence of category disordering overall; i.e., Category 1 (-.95), Category 2 (-.50), Category 3 (-.21), Category 4 (.12), Category 5 (.44). At an item level for this measure there was no category disordering.

Looking at threshold disordering for the Avoidance scale at Year 2, the Andrich thresholds did not increase as expected, suggesting that participants had difficulty differentiating among the category options. In this case, the Andrich thresholds increased between sequential categories as .17 (Category 1 and 2), -.47 (Category 2 and 3), .16 (Category 3 and 4), and .13 (Category 4 and

5).

Rasch Analysis of CISS: Overview of Results

Across all Rasch analyses for all scales (i.e., Task, Emotion, Avoidance, All Items) and time points (i.e., Year 1, Year 2, Chronic) examined, no items on the CISS had "poor" fit with the model based on infit and outfit mean-square statistics (i.e., < 0.33 to > 3.0(Fisher, 2007). In fact, across all of these analyses, the majority of CISS items had "excellent" or "good" fit with the model (i.e., 0.7 to 1.3 or 0.5 to 2.0, respectively), with only two items (6, 48) having slightly low fit at one time point (e.g., 2.1 outfit or 2.03 infit; see Tables 7 – 10).

Overall, none of the models looking at the three CISS scales or the full CISS measure across all follow-up time periods accounted for the desired level of having 60% of variance explained by the model (Fisher, 2007). However, for all of these analyses, the raw variance explained by the measure that was observed empirically closely approximated or maximized the value modeled by the Rasch estimates, with all differences between empirical and modeled variances being less than or equivalent to 1% (e.g., 41.2% and 41.8%; Table 11). Although these values were not ideal because they were all below the desired 60% threshold, the multidimensional models that examined the CISS scales separately performed uniformly better on this index than did the unidimensional models that examined all CISS items concurrently (i.e., values for multidimensional models ranged 37.6% to 49.9% and values for unidimensional models ranged 31.9% to 32.9%; Table 11). Furthermore, the unexplained variance in the first contrast ideally falls below 3 when a measure exhibits unidimensionality (Fisher, 2007). On this index, all unidimensional models using all CISS items had values greater than 3 (i.e., values ranged 8.1 to 9.4; Table 11). Conversely, all multidimensional models comparing CISS scales separately had eigenvalues less than 3 (i.e., values ranged 1.9 to 2.7; Table 11). The pattern of results observed in

these data for variance explained by measure and unexplained variance in the first contrast provide *clear evidence against the unidimensionality of the CISS and demonstrate that multidimensional models of the CISS consistently perform better than unidimensional models*.

Overall, Rasch analyses also demonstrated that all CISS scales (i.e., Task, Emotion, Avoidance) and the entire measure (i.e., All Items) hold up as reliable measures of coping style for persons with TBI at 1 year, 2 years, and chronic phases of recovery. Item reliability estimates from Rasch analyses ranged from .87 to .98, which correspond to the "good" to "excellent" ranges for item reliability (Table 11; (Fisher, 2007).

Additional results from Rasch analyses indicated that the CISS as used in this sample has adequate category functioning, with no major problems with category disordering across any of the scales or time points. In other words, each sequential category, or response option, (e.g., Category 1 "Not at all," Category 2 "Very little," Category 3 "Somewhat," Category 4 "Quite a bit," Category 5 "Very much") was associated on average with increasing item difficulty (i.e., intensity of agreement). These data provide no evidence of needing to reorganize or collapse category options for the CISS as used with persons with TBI in the acute or chronic phases of recovery.

Furthermore, in regards to establishing adequate item person targeting, examination of person distributions based on the overall percentage of participants who obtained the highest or lowest possible scores on the CISS scales across all analyses indicated that there were no significant problems with ceiling or floor effects. Additionally, the means for item difficulties and person abilities (shown in Rasch item person maps) across the CISS scales generally were matched well, which is one indicator used to establish good item person targeting (McHorney & Tarlov, 1995). However, additional Rasch data provided some concern regarding the precision of

measurement of coping style in this sample. The item-person maps provided with these Rasch analyses suggested that although the CISS items captured the full range of coping levels for the majority of the sample, for a small percentage of the sample, the scales showed poor precision in person ability estimates due to item difficulties under representing the range of the construct. In other words, for a few persons in the sample, the CISS items were not targeting the full range of coping ability reported. Therefore, although these observations did not indicate significant floor or ceiling effects, the trends in extreme scores across scales were meaningful for understanding how the CISS functions in assessing coping within a TBI sample.

For the *Task-oriented Coping* scale, there was clear evidence of extreme scores at the high end of the scale across all time points with much less evidence of extreme scores at the low end. In other words, although there was not a significant ceiling effect overall for the Task scale, there was a meaningful trend towards a ceiling effect more so than for a floor effect. Essentially, this trend suggests that for a handful of persons in this TBI sample the CISS did not adequately capture the high level of task coping ability they reported. This finding suggests that scores obtained for these persons underestimate their level of task-oriented coping ability and limit differentiation of persons with differences in task-oriented coping ability at the very high end of the construct. For the *Emotion-oriented Coping scale*, there were trends showing extreme scores at the high and low ends of the scales across all time points, with more evidence of low versus high extreme scores for the Year 2 time period. For the *Avoidance-oriented Coping* scale, there were trends showing extreme scores at the high and low ends of the scale across all time points, but there was more clear evidence for low extreme scores versus high extreme scores. Again, there were no significant floor or ceiling effects for the Emotion or Avoidance scales, but the data suggested trends for both ceiling and floor effects for both scales among a relatively small number of cases. As noted, these

trends suggest that for some persons with TBI the CISS either under- or overestimates the extent of their reported levels of emotion or avoidance coping, and at certain times post injury, the CISS is especially likely to overestimate their level of emotion or avoidance coping.

Overall, although a noticeable number of participants reported higher or lower amounts of coping ability than individual items were able to assess fully, the CISS scales did not show significant problems with targeting through ceiling or floor effects based on aggregate scores for this sample. However, items for the CISS scales could do a better job of providing uniformly precise measurement of coping styles by assessing a broader and more evenly distributed range of item difficulty (i.e., broader item difficulty distribution at extreme ranges and smaller gaps in item difficulties; (Baghaei, 2008).

Hypothesis 2

Hypothesis 2 predicted that the CISS shows a multidimensional structure of coping style among persons with moderate to severe TBI. Bivariate correlations assessed the relationships among different coping styles as measured by CISS scales and subscales. Table 4 presents descriptive correlations for the CISS scales and subscales with indices of well-being at follow-up and demographic characteristics of the sample.

As shown in Table 4, among the scales of the CISS, Task and Emotion coping were unrelated (r = .05). Conversely, Avoidance coping showed a strong relation to Task coping (r = .48) and a moderate relation to Emotion coping (r = .39). Within the Avoidance scale, Avoidance-Distraction showed a moderate relation to Task (r = .31) and to Emotion (r = .44) scales, whereas Avoidance-Social Diversion showed a strong relation to Task (r = .53) and a small relation to the Emotion scale (r = .21). This pattern of intercorrelations, particularly the lack of association between Task and Emotion coping, indicates that the CISS scales are not largely tapping the same

construct even among individuals recovering from a moderate to severe brain injury.

Furthermore, the results of Rasch analysis that modeled each CISS scale (i.e., Task, Emotion, Avoidance) and the full measure (i.e., all items) across follow-up time periods provided clear evidence that the CISS functions best as a multidimensional measure of coping rather than as a unidimensional measure of coping. Evidence from Rasch analysis supported the hypothesis that the CISS measures multidimensional coping most clearly in the amount of variance accounted for by each model and by the amount of unexplained variance in the first contrast for each model (Table 11). Across these data, the unidemsional models (i.e., all items) consistently performed poorer than did the multidimensional models (i.e., Task, Emotion, and Avoidance scales separate). Specifically, the unidimensional models accounted for less modeled and empirical variance and had greater than desired unexplained variance in first contrast, which is analogous essentially to having evidence of residual variance, factors, or dimensions for which the model did not account. Overall, the accumulation of evidence from correlational data and Rasch analysis data provide evidence against a unidimensional structure of coping as assessed with the CISS and consequently suggest that the CISS assesses a multidimensional structure of coping among persons recovering from TBI.

Additional evidence for the CISS as capturing a multidimensional construct of coping style in persons with TBI can also be observed in distinct relations between the individual scales and external indicators of well-being. Patterns of correlations consistent with a multidimensional construct of coping style would be observed in different associations among the CISS scales and well-being indicators among individuals recovering from a brain injury. This evidence was evaluated in Hypothesis 3.

Hypothesis 3

Hypothesis 3 predicted that the CISS would show sound criterion-related validity, as demonstrated by meaningful association with subjective and functional outcomes following TBI. Bivariate correlations assessed the relationships between coping style as measured by the CISS and functional well-being as measured by the Disability Rating Scale (DRS) and subjective well-being as measured by the Satisfaction with Life Scale (SWLS). Table 4 presents the descriptive correlations between CISS scales and outcomes. Disability at follow-up showed a significant relation to Task coping (r = -.18) and Emotion coping (r = .24). In particular, these correlations indicate that functional disability decreased with higher use of Task coping and lower use of emotion coping. Disability at follow up was unrelated to Avoidance coping (r = .06), including Avoidance-Social Diversion (r = .09) or Avoidance-Distraction (r = -.01). Life satisfaction at follow-up showed significant relation to Task (r = .17), Emotion (r = -.27), and Avoidance-Social Diversion (r = .18) but was unrelated to Avoidance (r = .09) and Avoidance-Distraction (r = .00). In particular, use of Task and Avoidance-Social Diversion coping was positively associated with life satisfaction, whereas use of Emotion coping was inversely associated with life satisfaction.

Hypothesis 4

Hypothesis 4 predicted that the CISS uniquely predicts subjective and functional well-being outcomes following TBI even after accounting for injury severity, sociodemographic characteristics, and global response bias.

Table 5 displays the results of a hierarchical multiple regression analyses predicting disability at follow-up as assessed with the Disability Rating Scale (DRS). After step 1, with age, education, injury severity as measured by days to follow commands, and disability at discharge as measured by the DRS in the model, $F(4, 298) = 12.68$, $p < .001$, $R^2 = .15$, indicating that demographic and injury severity characteristics accounted for 15% of the variance in disability

outcomes at follow up. After step 2, the addition of Positive Affectivity (PA) and Negative Affectivity (NA) significantly improved the model, accounting for 6% additional variance in disability outcome, $F_{change}(2, 296) = 12.01$, $p < .001$, total model $R^2 = .21$. After step 3, the addition of the CISS scales (i.e., Task, Emotion, Distraction, Social Diversion) significantly improved the model, accounting for an additional 5% of the variance in disability outcome, $F_{change}(4, 292) = 5.44$, $p = .001$; for the total model, $F(10, 292) = 10.04$, $p < .001$ $R^2 = .26$. At the final step, the squared semipartial correlations, which represent the amount of unique variance contributed to the model by each variable, indicated that several variables added unique variance to the total model: disability at discharge and emotion coping accounted for the most unique variance, followed by age, task coping, negative affectivity, days to follow commands, and social diversion coping.

Table 6 displays the results of the hierarchical multiple regression analyses predicting life satisfaction at follow-up as assessed with the Satisfaction with Life Scale (SWLS). After step 1, with age, education, injury severity as measured by days to follow commands, and disability at discharge as measured by the DRS in the model, $F(4, 300) = 1.55$, $p = .189$, $R^2 = .02$, indicating that this model including basic demographic and injury severity characteristics was non-significant, accounting for 2% of the variance in life satisfaction at follow-up. After step 2, the addition of PA and NA to the equation, the model was significant, accounting for an additional 7% of the variance in life satisfaction outcome, $F_{change}(2, 298) = 11.31$, $p < .001$, total model $R^2 = .09$. After step 3, the addition of the CISS scales significantly improved the model, accounting for another 7% of the variance in life satisfaction outcome, $F_{change}(4, 294) = 6.53$, $p < .001$; for the total model, $F(10, 292) = 5.75$, $p < .001$, $R^2 = .16$. At the final step, the squared semipartial correlations indicated that emotion coping, avoidance coping, and positive affectivity added unique variance to the total model.

CHAPTER 4
DISCUSSION

Among persons with TBI, coping style can be reliably and validly assessed using the CISS. This measure demonstrates good psychometric properties based on the confluence of evidence from approaches based in classical test theory and item response theory, although findings also suggest ways the measure might be strengthened. As expected, coping responses among people with TBI meaningfully associate with indicators of physical and psychological well-being. Moreover, coping style uniquely predicts functional disability and life satisfaction during recovery from TBI beyond information based on injury severity, demographic characteristics, and global response bias.

Reliability of the CISS

Overall, this study confirmed the hypothesis that the CISS has adequate reliability as a measure of coping style among persons with TBI. Of note, this study demonstrated that each of the CISS scales (i.e., Task, Emotion, Avoidance) were adequately reliable across short-term (1 and 2 years) and long-term ($\geq$ 5 years) adjustment to injury. Furthermore, the CISS demonstrated strong reliability across persons with negligible to severe disability.

These findings support the clinical and research use of the CISS to assess coping responses among individuals recovering from TBI. These findings also provide initial evidence that the psychometric strengths of the CISS identified using healthy populations extend to include adults with acquired brain injury. Establishing the reliability of the CISS among persons recovering from TBI also provides necessary foundation for examining questions of validity, factor structure, and utility of the measure within this population. These findings also are particularly noteworthy in providing evidence that the CISS not only can reliably assess coping overall among persons with

moderate to severe TBI, but that the CISS can reliably discriminate the major types of coping, task-oriented, emotion-oriented, and avoidance-oriented, within this population.

These findings are consistent with prior work demonstrating the reliability of the CISS among healthy populations (Boysan, 2012; Cosway et al., 2000; Endler & Parker, 1999; Furukawa et al., 1993; Rafnsson et al., 2006), persons with physical health problems (Hurt et al., 2011), and persons with mental health problems (McWilliams et al., 2003). These findings build on prior research regarding the assessment of coping after brain injury (Anson & Ponsford, 2006a; Bryant et al., 2000; Curran et al., 2000; Malia et al., 1995) by explicitly working to establish the psychometric integrity of a generally well-validated coping measure within a TBI population before examining relationships among coping responses and rehabilitation or other outcomes.

In regards to the ability to assess reliably coping responses after TBI, these findings generally are consistent with those of Malia et al. (1995) who reported similar results using a different coping measure among a mixed group of rehabilitation patients. Furthermore, such findings help clarify questions surrounding the ability for persons with moderate to severe TBI to complete reliably measures such as the CISS, given the array of cognitive impairments they often experience (Dikmen et al., 2009). In particular, the CISS surprisingly demonstrated good reliability even at 1 year after injury, which as a relatively early stage in recovery often has been associated with significant global impairments that might otherwise adversely influence the ability to obtain reliable estimates of coping style in this population (Williams, Rapport, Hanks, Millis, & Greene, in press).

Dimensionality and overall function of the CISS

Similarly, it might have been expected that global cognitive deficits associated with TBI would yield an undifferentiated (i.e., global) coping response, in which specific types of coping

are not discernible and instead give rise to a generalized mass of positive or negative reactions to stress. Therefore, the findings regarding the dimensionality of the CISS in this population were particularly striking. This study confirmed the hypothesis that coping style among persons with TBI characteristically shows a multidimensional structure as measured by the CISS. In particular, this study found that the CISS functions much better psychometrically as a multidimensional rather than as a unidimensional measure of coping style. In other words, evidence based on statistical approaches from classical test theory (CTT) and item response theory (IRT; Rasch analyses) supported using the Task, Emotion, and Avoidance-oriented coping scales considered separately rather than including all items of the CISS when assessing coping responses after TBI. This finding parallels prior research on coping style and fits with the structure of coping reported by the CISS developers (Endler & Parker, 1999). Therefore, it is likely that persons with TBI engage in similar types of coping responses as non-brain injured persons with whom coping styles traditionally have been examined.

Overall, the findings are consistent with prior work across the coping literature generally conceptualizing coping as a multidimensional construct (Carver et al., 1989; Endler & Parker, 1990; Folkman & Moskowitz, 2004; Pearlin & Schooler, 1978). In particular, findings from this study converge with evidence supporting the proposed three-factor structure of the CISS (i.e., task, emotion, avoidance; (Endler & Parker, 1990). Generally, this finding fits with the theory that coping responses encompasses multiple dimensions, which have been categorized within a hierarchical framework (Skinner et al., 2003). Furthermore, the current study helps clarify whether persons with TBI cope with stress similarly to persons with other medical problems, such as orthopedic injury (Curran et al., 2000; Moore & Stambrook, 1995). Overall, this study offers particularly strong evidence in support of the three-factor model of coping responses assessed with

the CISS given the complementary findings from two statistical approaches examining the dimensionality of the CISS. In conjunction with the excellent reliability findings for the CISS, this dimensionality finding adds to the accumulating body of support for the psychometric soundness of the CISS as a measure of coping responses across diverse populations, including moderate to severe TBI.

Furthermore, rating scale analyses (i.e., Rasch analyses) enhanced understanding regarding the psychometric characteristics of the CISS as used in this population. Findings indicated that all 48 items of the CISS contribute meaningfully to the function of the measure. Findings also demonstrated that persons with TBI use the response options on the CISS as intended by test developers (Endler & Parker, 1999), such that response categories represent increasing levels of coping (e.g., “not at all” to “very much”). Although CISS items and categories functioned well overall, findings indicated one particular weakness in the scale structure as used with this sample: Items across the scales characteristically underrepresented the range of coping, demonstrating restricted range of item difficulty for most scales across time. In other words, items on the CISS often reflected a moderate range of coping ability rather than also having reflected a very high or very low level of coping.

Therefore, these findings suggest that the CISS might be improved for use among people with TBI by adding items that assess better the lower and upper ranges of specific coping styles. In particular, findings support the addition of items that reflect high levels of task coping. Designing items to assess *higher* task coping than currently captured by the CISS necessitates consideration of what types of items consistently appear at the extreme ends of the task coping dimension. In this study, clear patterns emerged for *difficult* task items (e.g., Item 1, “In difficult situations, I schedule my time better;” Item 10, “In difficult situations, I outline my priorities;”

Item 26, “In difficult situations, I take corrective action immediately”) and *easy* task items (e.g., Item 6, “In upsetting situations, I do what I think is best;” Item 2, “In difficult situations, I focus on the problem and see how I can solve it;” Item 27:, “In difficult situations, I think about the event and learn from my mistakes;” Item 42, “In stressful situations, I make an extra effort to get things done”). Conceptually, the more difficult task items appear to reflect a stronger overall approach orientation for dealing with stressors than the easier task items, particularly in the extent to which urgency of action is implied. Perhaps more difficult task coping items might reflect an even stronger sense of commitment and immediacy to take action than current items, such as, “*In difficult situations, I focus all of my time and resources on the problem until it is resolved* or *in stressful situations,” “I make dealing with the stressor my top priority*.” Additionally, it seems noteworthy that actions at the upper end of item difficulty (hardest to endorse) such as outlining priorities and scheduling require complex higher-order thinking, as well as sustained action; in contrast, items at the low end (easiest to endorse) are generally global statements of intention that do not require complex thinking or action. As such, it may be that the need for items at the upper end of task coping for this population reflect additional actions that reflect “active” coping but that require activity that is relatively less cognitively complex, such as, “*In difficult situations, I try hard,” or “I work hard at getting better*.” This hypothesis is consistent with the findings that endorsement of task coping decreased as a function of disability.

For emotion and avoidance coping, findings support the addition of items that capture high and low levels of coping; however, evidence more strongly indicates a need for low items for these scales than for high items. As with the task coping items, several items emerged as consistently reflecting the highest and lowest emotion and avoidance coping levels. Among the emotion coping items, *difficult* items (e.g., Item 25, “In upsetting situations, I ‘freeze’ and not know what to do;”

Item 45, “In upsetting situations, I take it out on other people;” Item 7, “In upsetting situations, I become preoccupied with aches and pains”) and *easy* items (e.g., Item 28, “In upsetting situations, I wish I could change what happened or how I felt;” Items 30, 19, 38 and 14, I worry, I become very upset, I get angry, and I get tense, respectively) are informative for considering potential items to add to expand the low end range of this scale. The midrange to higher items on this scale appear to capture intense emotional responses to stress, such as guilt, preoccupation, and denial. The lowest items on this scale currently focus on intense experience of negative emotion and also capture a sense of regret. Perhaps even lower-level emotion coping items might reflect milder forms of distress or decreased emphasis on changing responses in the future, such as, *“In difficult situations, I feel tense until the stressor resolves”* or *“In stressful situations, I feel down more than usual*.” Additionally, given the unique cognitive challenges associated with TBI robust research indicating increased risk for depression it might be worthwhile to test items that tap less “active” emotions such as feelings of *hopelessness, overwhelm, helplessness, as well as frustration*. The need for items on the lower end of the scale that invoke emotional experiences characteristic of TBI also is supported by findings CTT estimates of reliability were generally lower among people with moderate and severe disability as compared to people with mild or no disability.

Among the avoidance coping items, *difficult* items (e.g., Item 9, “In upsetting situations, I window shop;” Item 23, “In stressful situations, I go to a party”) and *easy* items (e.g., Item 31, “In upsetting situations, I spend time with a special person;” Item 35, “In difficult situations, I talk to someone whose advice I value”) also emerged across time points. Interestingly, the items reflecting the highest avoidance involved external activities unrelated to processing or dealing with the stressor, and not coincidentally would require transportation, planning, and other resources that may not be independently controlled by the person with TBI. In contrast, items at the low end of

the scale (easiest to endorse) involved seeking social contact or support, which do not necessarily require external resources and independence (i.e., social support may be found in the home). The differences between high and low avoidance items suggest that social diversion coping reflects a lower level of avoidance than distraction coping attempts, which makes sense in the context of findings supporting the benefits of social coping efforts but not avoidance coping in general; however, it might also reflect that this type of coping is not readily available to many people with moderate to severe TBI. To expand the lower range of this scale and test this hypothesis, items might assess distraction that does not involve costly or out-of-home activities, or those that require high levels of functional independence, such as *watching television, listening to music or playing video games, or general attempts to get one's mind off the problem*. Added items might also reflect social contact seeking while emphasizing less avoidance and more tolerance of the stressor. Other items on this scale involving generally spending time with people (e.g., Item 4, "In upsetting situations, I try to be with other people") fell in the midrange of avoidance coping, suggesting that lower items might need to capture explicitly less avoidant behavior than described in such general social support statements. For example, lower avoidance coping items might include "*In difficult situations, I seek help from a close friend* or *in stressful situations," "I count on other people for support,"* although it is unclear how such socially-based items might be perceived differently by participants from existing item.

In consideration of the range of coping abilities that characterized this sample and the capacity of the CISS to asses these abilities fully, it is important to distinguish between how the sample performed across these scales overall and how the sample performed in comparison to normative groups. Overall, the sample included a few persons with greater levels of task coping than were adequately assessed using the CISS, and similarly included a few persons with lower

levels of emotion and avoidance coping than were assessed. Therefore, it might appear that persons recovering from TBI have high task and low emotion and avoidance coping abilities, which generally would be desirable for health and well-being. However, normative comparisons using classical test theory approaches indicated greater emotion coping and less task coping among these participants with TBI as compared to healthy adults, which reinforces the importance of assessing coping style after TBI.

Criterion validity of the CISS

In further examining this measure, this study provided evidence supporting the hypothesis that the CISS scales have good criterion-related validity in that they meaningfully relate to subjective and functional outcomes following TBI. In particular, functional disability increased with use of emotion coping whereas disability decreased with use of task coping. Disability was unrelated to use of avoidance coping strategies. Conversely, life satisfaction decreased with use of emotion coping and increased with use of task coping. Life satisfaction was unrelated to use of avoidance coping generally but was related positively to the social diversion subtype of avoidance coping.

Therefore, it appears that responses to stress after TBI characterized by emotional coping strategies correspond with adverse physical and subjective well-being for individuals whereas responses characterized by using problem- or task-oriented coping strategies correspond with favorable physical and subjective well-being. These findings also suggest that avoiding dealing with stress generally does not correspond meaningfully with physical or subjective well-being after TBI; however, seeking social support as a specific means of diverting stress does correspond positively with subjective well-being for these individuals. Overall, the meaningful patterns

observed among well-being outcomes and coping styles assessed by the CISS provide support for the validity of the measure for assessing coping after TBI.

These findings are consistent with prior research indicating that task-oriented coping styles are associated with positive health and well-being outcomes whereas emotion-focused coping styles are associated with adverse health and well-being outcomes (Bombardier et al., 1990; Cosway et al., 2000; Endler & Parker, 1994). However, these findings contrast with issues described by Folkman and Moskowitz (2004) suggesting that persons facing unresolvable stressors might fare better overall by using emotion coping rather than task coping strategies. For persons with moderate to severe TBI who undoubtedly deal with some unresolvable stressors in their daily life, these findings clarify the overall benefits associated with facing stressors with a task-oriented approach. It should be noted, however, that the use of task-oriented coping does not preclude the use of emotion-oriented coping as well, and the CISS does not differentiate among various types of stressors persons might experience. Therefore, it is quite possible that for dealing with the accumulation of stressors in life, persons recovering from TBI might benefit more consistently from using a task-oriented coping style rather than an emotion-oriented coping style, but for dealing with specific types of stressors, they might benefit differently from adopting certain coping responses. Understanding overall what types of coping strategies are most useful for such persons will be helpful for designing assessment and intervention strategies to generate positive change during rehabilitation. However, it also is quite possible that persons with TBI would benefit from being taught how to differentiate in which contexts specific coping strategies are most effective. For example, it might be useful for patients to learn how to use effective task coping strategies generally and to learn how to differentiate situations in which other coping responses might be best suited, such as when stressors are unchangeable. Additionally, these findings help clarify the

relationship between avoidance-oriented coping efforts, which include several distinct response options, and health and well-being, which might differ based on type of avoidance strategy used (Carver et al., 1989). In regards to social diversion as a form of avoidance, these findings are consistent with prior work (Carver et al., 1989) describing the potential benefits of using social support to deal effectively with stress. These findings also underscore the necessity of distinguishing the types of avoidant coping responses persons with TBI might use, as the potential implications for well-being differ.

Beyond establishing the psychometric characteristics and strengths of using the CISS to assess coping within the moderate to severe TBI population, this study provided compelling evidence regarding the utility of measuring coping style to improve prediction of recovery outcomes. As expected, coping style predicted subjective and functional well-being following TBI even after accounting for injury severity, sociodemographic factors, and global response bias (i.e., positive and negative affectivity). Specifically, coping style uniquely contributed to the prediction of functional disability across short-term and long-term recovery from TBI, with task, emotion, distraction, and social diversion coping responses all adding meaningful information. Additionally, coping style improved prediction of life satisfaction following TBI, with emotion and social diversion coping providing unique information. Thus, knowing how a person copes with stress in the years after brain injury uniquely expands understanding about how well that person will be physically functioning and how satisfied or happy he or she will be with life overall.

This finding supporting the unique predictive value of coping style extends prior work identifying health and well-being benefits associated with specific coping styles and adjustment to medical illness or rehabilitation from injury (Bombardier et al., 1990; P. A. Hall et al., 2011; Hanson et al., 1993; Victorson et al., 2005). This finding also is consistent with prior research

emphasizing the general importance of psychological functioning in relation to TBI recovery (Dawson et al., 2007) and with authors who have identified coping style as a likely key contributor to this process (Anson & Ponsford, 2006a; Curran et al., 2000; Dawson et al., 2007). Remarkably, this is the first known study to have demonstrated that coping responses actually can predict physical and subjective well-being even years after TBI. This finding is particularly interesting given that prediction of outcomes following brain injury often focuses primarily on physical injury characteristics or stable person characteristics, such as age or premorbid cognitive functioning. Thus, this study supports well-known understandings by clinicians and healthcare professionals in the rehabilitation setting that psychosocial characteristics have substantial influence on the recovery process after a moderate to severe TBI.

The applied ecological significance of the present study's findings are not directly apparent, because enhanced power of prediction must be translated to beneficial action, such as identifying characteristics that signal risk and effectively using the information to develop and target interventions. In the case of TBI, any meaningful factor that can be used reasonably to improve outcome prediction, and potentially to affect recovery if targeted via intervention, is worthwhile in the context of the serious impairments these individuals experience. Any possible improvement in prediction would likely be useful in this context where even small improvements in functioning or happiness can represent real life appreciable differences for the persons affected. Additionally, a factor that may seem relatively small on an individual level can have a much larger impact when the effects are aggregated across an entire population affected by TBI. Therefore, these findings should be taken as support for the practical utility of assessing coping responses among persons with brain injury with implications for improving the accuracy of prognosis and potentially for identifying ways to intervene in promoting better outcomes.

Comparison of CTT and IRT

One inherent purpose of this study was to determine how findings from classical test theory (CTT) and item response theory (IRT; in this case, Rasch analysis) converge to enrich understanding of the CISS as used among persons with TBI. CTT and IRT differ fundamentally in several key areas. For example, CTT is data-driven in that data are used to create models whereas IRT is model-driven in that data are compared to ideal (e.g., Rasch) models. Furthermore, in CTT item difficulty and person ability are inseparable statistically whereas in IRT item difficulty and person ability are estimated independently of one another. Perhaps one of the most hallmark differences between CTT approaches and Rasch analysis is that CTT assumes observations reflect interval-level measurement whereas Rasch analysis actually assesses directly the interval-level measurement properties of the instrument. This difference is key for pursuing good measurement, such that it is essential to know that increasing values on a scale represent consistently increasing amounts of the construct of interest. CTT approaches are limited in that the analyses used assume interval-level measurement but CTT does not establish that the measures used are capable of producing interval level data, which might render inaccurate findings. Therefore, Rasch analysis provides crucial information regarding the ability of the measure to produce interval level-data, which if established, then permits for valid inferences based in CTT or IRT approaches (Bond & Fox, 2007; McAllister, 2008).

Within this study in particular, Rasch analysis confirmed assumptions of CTT by establishing that the CISS can provide interval-level measurement, meaning that the CISS can be used among persons recovering from TBI without altering the measure to meet expectations for interval-level measurement. Rasch analysis findings also confirmed CTT analyses showing that the measure is reliable when used with persons with moderate to severe TBI, and confirmed

theoretical assumptions that the CISS functions as a multidimensional measure of coping style. Furthermore, CTT analyses allowed for establishing that the CISS has good criterion validity in this sample and that coping style predicts meaningful subjective and functional outcomes after brain injury. However, Rasch analysis provided additional information regarding how the CISS functions within this TBI population by highlighting the extent to which scales adequately assess or target the range of coping ability possessed by this sample. In turn, these observations can guide future improvements of the scale. Were only CTT approaches used, the relative weakness of the scale in assessing the extremes of task and emotion coping would have gone unnoticed. Overall, these approaches together provided a more comprehensive understanding of the CISS as a measure and coping style in general among persons with TBI than would be possible with either approach alone.

Limitations and future directions

A limitation of this study is that findings may not generalize to all persons with TBI given the restriction of injury severity in the sample, such that persons with mild or very severe brain injuries were not included. Similarly, it is quite possible that the high level of care these participants received influenced their recovery outcomes, meaning that these findings may not generalize to persons with TBI who receive typical or lower levels of care during rehabilitation. Additionally, this study is limited by being archival in nature with hypotheses and analyses determined retrospectively. Thus, future work should use prospective designs to test the predictions of this study.

Replication studies should examine the hypotheses of this study using a sample that represents the breadth of injury characteristics and treatment options available to persons with TBI. In particular, this study should be replicated using persons with all severities of TBI who are

physically and cognitively capable of participation and using more typical rehabilitation facilities rather than model system hospitals. Specifically, future work should asses the reliability and validity of the CISS among persons with mild brain injuries in order to generalize its utility to a major subgroup of the TBI population. Furthermore, based on findings that items of the CISS do not consistently assess the lowest and highest ranges of coping, future studies might test the utility of adding items to broaden the scope of coping ability assessed in this population. If such test development and refinement were conducted, additional examination of psychometric properties of the revised CISS would be required. Furthermore, future research might use Rasch analysis to determine if the CISS functions equivalently across various disability levels.

Perhaps most importantly, future research should seek to expand understanding regarding how best to intervene and alter coping styles in efforts to improve recovery outcomes following TBI. Identifying those adults with TBI most at risk due to low task coping or high emotion coping is a first step. The challenge of developing an effective intervention would require identifying methods for enhancing adaptive coping responses, changing maladaptive coping responses, and assessing stability of such changes. Longitudinal studies would need to assess the connections among coping styles, interventions to alter coping, and functional and subjective recovery outcomes to understand the effectiveness of the intervention and potential pathways of change. The work of Anson and Ponsford (2006a) was successful in part as a study designed to alter coping style among persons with TBI using a cognitive-behavioral approach. Although their treatment increased adaptive coping responses initially, these changes were not maintained and indicators of psychological well-being (e.g., anxiety, depression, self-esteem) were unaffected in the short term. Hence, an effective intervention would likely combine increasing and improving the repertoire of healthy coping behaviors with identifying contexts in which those strategies are most likely to be

useful and productive versus ineffective and detrimental. Long-term follow up would be important, because clinical outcomes likely require time to change. Future work in this area should continue to explore intervention options capable of producing lasting changes in coping responses and subjective well-being among those with brain injury.

Conclusions

Paramount to understanding coping among persons with TBI, the converging findings of this study provide evidence that coping style can be assessed reliably and validly in this population despite prevalent cognitive, psychological, and physical impairments (Dikmen et al., 2009; Hesdorffer et al., 2009; Zaloshnja et al., 2008). Through complementary use of approaches based in classical test theory and item response theory, this study establishes the soundness of the CISS as a measure of coping after brain injury, which was a particularly rigorous challenge in that examinees had cognitive deficits that could undermine both completing the measure and the coping constructs underling it. In particular, findings from rating scale analyses (i.e., Rasch analyses) confirm the reliability and multidimensionality shown through traditional methods and extend understanding by highlighting ways in which the CISS may sometimes underestimate (task) or overestimate (emotion and avoidance) coping through restriction of item difficulty across scales.

Although important to establish a validated measure for assessing coping, the real endeavor is to determine the clinical implications and utility of identifying coping responses during recovery from brain injury. This study reveals the unique role of coping style in predicting functional disability and life satisfaction in the years after injury, with better outcomes associated with approaching problems directly rather than dwelling on distress. To this end, TBI rehabilitation programs might benefit from appropriately targeting coping style in treatment in order to improve functional and subjective well-being for these individuals. Ultimately, the greatest use and greatest

promise inherent to these findings will be working not only to predict recovery outcomes but also to change them.

APPENDIX A

Table 1. Demographic, Injury-related, and Psychosocial Characteristics of Participants with Traumatic Brain Injury (*N* = 331).

Variable	*M*	*(SD)*	*Range*
Age at follow-up (years)	44.0	(13.5)	18 – 90
Education (years)	11.9	(2.1)	6 – 18
Time since injury (years)	6.1	(4.9)	1 – 15
Glasgow Coma Scale (total at ED admission)	9.3	(4.2)	3 – 15
Days to Follow Commands	7.2	(12.1)	0.5 – 99
Disability at Discharge (DRS)	6.5	(2.9)	0 – 20
Coping Inventory for Stressful Situations (CISS)			
Task Coping	57.3	(13.1)	16 – 80
Emotion Coping	44.1	(13.7)	16 – 80
Avoidance Coping	41.9	(12.2)	16 – 80
Distraction	19.1	(7.1)	8 – 40
Social Diversion	15.0	(5.2)	5 – 25
Positive Affectivity (PANAS)	32.9	(8.9)	10 – 50
Negative Affectivity (PANAS)	15.7	(6.9)	10 – 47
Disability at Follow up (DRS)	2.3	(2.0)	0 – 8
Satisfaction with Life at Follow up (SWLS)	17.7	(7.8)	5 - 35

Note. Days to follow commands = Motor subscale of Glasgow Coma Scale, Days from injury to follow commands; DRS = Disability Rating Scale; PANAS = Positive and Negative Affectivity Scale; SWLS = Satisfaction with Life Scale.

Table 2. Coping Inventory for Stressful Situations: Descriptives and Alpha Reliabilities among Participants with TBI at 1, 2, 5, 10 or 15 Years Post Injury.

CISS Scale	Total Sample (N = 331)	Year 1 (n = 62)	Year 2 (n = 64)	Year 5 (n = 93)	Year 10 (n = 61)	Year 15 (n = 51)	$F_{(4, 326)}$	η^2
Task								
Alpha	.91	.92	.93	.90	.89	.90		
Item *M* (*SD*)	3.58 (0.30)	3.58 (0.34)	3.50 (0.32)	3.70 (0.34)	3.60 (0.30)	3.45 (0.31)		
Scale *M* (*SD*)	57.26 (13.08)	57.34 (13.39)	55.91 (14.34)	59.12 (11.71)	57.53 (12.68)	55.20 (13.86)	0.95	.01
Emotion								
Alpha	.89	.89	.86	.88	.86	.93		
Item *M* (*SD*)	2.76 (0.44)	2.82 (0.53)	2.57 (0.42)	2.86 (0.50)	2.86 (0.40)	2.58 (0.41)		
Scale *M* (*SD*)	44.07 (13.77)	45.18 (13.50)	41.17 (12.16)	45.75 (13.37)	45.73 (13.56)	41.30 (16.33)	1.75	.02
Avoidance								
Alpha	.84	.89	.87	.83	.81	.80		
Item *M* (*SD*)	2.62 (0.60)	2.78 (0.61)	2.51 (0.58)	2.63 (0.62)	2.61 (0.63)	2.55 (0.61)		
Scale *M* (*SD*)	41.90 (12.18)	44.47 (13.14)	40.17 (12.58)	42.09 (11.79)	41.68 (11.69)	40.86 (11.61)	1.17	.01
Distraction								
Alpha	.79	.83	.84	.78	.74	.73		
Item *M* (*SD*)	2.39 (0.46)	2.53 (0.45)	2.25 (0.39)	2.41 (0.51)	2.34 (0.46)	2.41 (0.54)		
Scale *M* (*SD*)	19.12 (7.11)	20.24 (54.48)	18.03 (7.29)	19.32 (6.99)	18.70 (7.06)	19.30 (6.88)	0.83	.01
Social Diversion								
Alpha	.77	.80	.80	.80	.68	.72		
Item *M* (*SD*)	3.01 (0.42)	3.19 (0.38)	2.93 (0.44)	3.07 (0.44)	3.03 (0.40)	2.73 (0.50)		
Scale *M* (*SD*)	15.03 (5.19)	15.95 (5.06)	14.64 (5.46)	15.35 (5.24)	15.15 (4.91)	13.67 (5.09)	1.58	.02
Unidimensional (all items)								
Alpha	.91	.93	.90	.88	.90	.93		
Item *M* (*SD*)	2.98 (0.62)	3.06 (0.62)	2.86 (0.63)	3.05 (0.67)	3.01 (0.61)	2.87 (0.63)		
Scale *M* (*SD*)	143.08 (28.53)	146.98 (31.24)	137.25 (26.31)	146.56 (24.93)	144.44 (28.55)	137.67 (32.79)	1.97	.02

Note. F (4, 326), all comparisons of follow-up years$p > .05$ for all scales and unidimensional (all items).

Table 3. Coping Inventory for Stressful Situations (CISS) Descriptive Statistics and Alpha Reliabilities among Participants with No, Mild, Partial, and Moderate-Severe Disability.

CISS Scale	No Disability (n = 78)	Mild (n = 78)	Partial (n = 79)	Moderate-Severe (n = 80)	$F_{(3, 311)}$	p	η^2
Task							
Alpha	.90	.91	.91	.88			
Item *M* (*SD*)	3.89 (0.32)	3.64 (0.33)	3.24 (0.35)	3.49 (0.30)			
Scale *M* (*SD*)	62.24 (11.28)[1]	58.38 (12.10)[1,2]	51.76 (13.78)[3]	55.90 (13.23)[2,3]	9.35	< .001	.08
Emotion							
Alpha	.84	.90	.92	.83			
Item *M* (*SD*)	2.42 (0.52)	2.72 (0.50)	2.80 (0.39)	3.02 (0.45)			
Scale *M* (*SD*)	38.67 (10.91)[2]	43.54 (13.66)[1,2]	44.86 (15.48)[1]	48.33 (12.73)[1]	7.31	< .001	.07
Avoidance							
Alpha	.84	.87	.86	.81			
Item *M* (*SD*)	2.60 (0.65)	2.64 (0.61)	2.45 (0.54)	2.76 (0.62)			
Scale *M* (*SD*)	41.51 (11.34)[1]	43.32 (12.81)[1]	39.24 (12.91)[1]	44.13 (11.97)[1]	2.14	.096	.02
Distraction							
Alpha	.78	.82	.78	.77			
Item *M* (*SD*)	2.28 (0.38)	2.43 (0.48)	2.29 (0.47)	2.58 (0.51)			
Scale *M* (*SD*)	46.63 (6.83)[1]	19.40 (7.25)[1]	18.33 (7.15)[1]	20.60 (7.34)[1]	1.92	.127	.02
Social Diversion							
Alpha	.74	.81	.79	.72			
Item *M* (*SD*)	3.12 (0.46)	3.01 (0.45)	2.66 (0.36)	3.11 (0.44)			
Scale *M* (*SD*)	15.61 (4.68)[1]	15.09 (5.29)[1,2]	13.29 (5.50)[2]	15.59 (5.20)[1]	3.31	.021	.03
Unidimensional (all items)							
Alpha	.89	.92	.93	.90			
Item *M* (*SD*)	2.97 (0.83)	3.00 (0.67)	2.82 (0.53)	3.09 (0.56)			
Scale *M* (*SD*)	142.45 (23.77)[1,2]	144.28 (28.69)[1,2]	135.55 (32.07)[2]	143.35 (28.88)[1,2]	2.68	.047	.03

Note. Group x CISS Scale interaction, $F(6, 620) = 8.39$, $p < .001$, partial eta^2 = .08. Post hoc univariate ANOVAs followed by Tukey tests; means with different superscripts differ at $p < .05$. Disability level assessed via the Disability Rating Scale (DRS).

Table 4. Descriptive Correlations: Coping Style, Well-being, and Demographic Characteristics (N = 331).

	1	2	3	4	5	6	7	8	9	10	11	12
1. Task Coping (CISS)	1.00											
2. Emotion Coping (CISS)	.05	1.00										
3. Avoidance Coping (CISS)	.48***	.39***	1.00									
4. Avoidance-Distraction[1]	.31***	.44***	.89***	1.00								
5. Avoidance-Social Diversion[1]	.53***	.21***	.79***	.46***	1.00							
6. Disability at Follow-up (DRS)	-.18**	.24***	.06	.09	-.01	1.00						
7. Life Satisfaction at Follow-up (SWLS)	.17**	-.27***	.09	.00	.18**	-.18**	1.00					
8. Positive Affectivity (PANAS)	.48***	-.03	.24***	.10	.33***	-.16**	.23***	1.00				
9. Negative Affectivity (PANAS)	-.19***	.47***	.09	.18**	-.04	.27***	-.17**	-.13*	1.00			
10. Age at follow-up	-.16**	-.09	-.18**	-.09	-.21***	.17**	.06	-.16**	-.01	1.00		
11. Education	.13*	-.15**	-.06	-.09	.01	-.17**	.10	.10	-.13*	.05	1.00	
12. Days to Follow Commands	.07	-.11	.09	.10	.03	.15**	.09	.04	-.09	-.08	.02	1.00
13. Disability at Discharge (DRS)	.06	-.04	.09	.09	.04	.29***	.08	-.08	.06	.00	-.02	.32**

Note. CISS = Coping Inventory for Stressful Situations; DRS = Disability Rating Scale; SWLS = Satisfaction with Life Scale; PANAS = Positive and Negative Affectivity Scale; Days to follow commands = Motor subscale of Glasgow Coma Scale, Days from injury to follow commands.

1. Subscales of the CISS Avoidance Coping scale.

*$p < .05$, **$p < .01$, ***$p < .001$

Table 5. Hierarchical multiple regression predicting disability at follow up (DRS).

Variables	sr^2	*B*	*F* Change	*df*	R^2 Change	Sig *F* Change	*t*
Step 1			12.68	4, 298	.15	< .001	
Age	.03	.18					3.36**
Education	.03	-.17					-3.22**
Days to Follow Commands	.01	.09					1.52
Disability at Discharge (DRS)	.06	.26					4.53***
Step 2			12.01	2, 296	.06	< .001	
Age	.03	.17					3.25**
Education	.02	-.14					-2.58*
Days to Follow Commands	.01	.12					2.16*
Disability at Discharge (DRS)	.04	.23					4.10***
Positive Affectivity (PANAS)	.01	-.08					-1.40
Negative Affectivity (PANAS)	.05	.24					4.51***
Step 3			4.54	4, 292	.05	.001	
Age	.03	.19***					3.55**
Education	.01	-.10					-2.00*
Days to Follow Commands	.02	.14*					2.47*
Disability at Discharge (DRS)	.05	.25***					4.62***
Positive Affectivity (PANAS)	.00	-.03					-0.45
Negative Affectivity (PANAS)	.01	.13*					2.08*
Task Coping (CISS)	.02	-.17*					-2.58*
Emotion Coping (CISS)	.03	.21**					3.26**
Distraction (CISS)	.00	-.04					-0.63
Social Diversion (CISS)	.01	.10					1.49

Note. CISS = Coping Inventory for Stressful Situations; DRS = Disability Rating Scale; PANAS = Positive and Negative Affectivity Scale; Days to follow commands = Motor subscale of Glasgow Coma Scale, Days from injury to follow commands.

Total model, F (10, 292) = 10.04, $p < .001$, $R^2 = .26$.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 6. Hierarchical multiple regression predicting satisfaction with life at follow up (SWLS).

Variables	sr^2	*B*	*F* Change	*df*	R^2 Change	Sig *F* Change	*t*
Step 1			1.55	4, 300	.02	.189	
Age	.00	.06					1.07
Education	.01	.09					1.61
Days to Follow Commands	.01	.09					1.48
Disability at Discharge (DRS)	.00	-.01					-0.09
Step 2			11.31	2, 298	.07	< .001**	
Age	.01	.10					1.72
Education	.00	.05					0.94
Days to Follow Commands	.00	.06					1.06
Disability at Discharge (DRS)	.00	.03					0.49
Positive Affectivity (PANAS)	.05	.22					3.92***
Negative Affectivity (PANAS)	.02	-.13					-2.23*
Step 3			6.53	4, 294	.07	< .001**	
Age	.01	.11					1.91
Education	.00	.03					0.57
Days to Follow Commands	.00	.05					0.78
Disability at Discharge (DRS)	.00	.00					-0.05
Positive Affectivity (PANAS)	.02	.17**					2.78**
Negative Affectivity (PANAS)	.00	.01					0.09
Task Coping (CISS)	.00	.00					-0.02
Emotion Coping (CISS)	.06	-.30***					-4.44***
Distraction (CISS)	.00	.04					0.62
Social Diversion (CISS)	.02	.19**					2.67**

Note. CISS = Coping Inventory for Stressful Situations; SWLS = Satisfaction with Life Scale; PANAS = Positive and Negative Affectivity Scale; Days to follow commands = Motor subscale of Glasgow Coma Scale, Days from injury to follow commands.

Total model, $F(10, 292) = 5.75$, $p < .001$, $R^2 = .16$.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 7. Fit Mean-square Statistics for CISS All Items.

Year	1 (*n*= 104)		2 (*n*= 90)		Chronic (*n*= 205)		Year	1 (*n*= 104)		2 (*n*= 90)		Chronic (*n*= 205)	
Item	Infit	Outfit	Infit	Outfit	Infit	Outfit	Item	Infit	Outfit	Infit	Outfit	Infit	Outfit
1	0.89	0.93	1.03	1.00	1.08	1.10	26	0.80	0.82	0.80	0.85	0.81	0.86
2	1.02	1.03	0.89	0.96	1.02	1.08	27	0.98	0.92	0.60	0.61	0.81	0.84
3	1.10	1.04	1.03	1.06	1.03	1.02	28	1.21	1.27	0.86	0.89	0.90	0.92
4	1.31	1.69	1.09	1.07	1.00	1.00	29	0.78	0.75	0.94	0.97	0.96	0.97
5	1.18	1.17	1.21	1.21	1.12	1.13	30	0.94	0.93	1.18	1.27	1.00	0.99
6	1.59	1.67	1.11	1.09	1.01	1.19	31	0.91	0.89	0.92	0.90	0.96	0.99
7	1.15	1.09	1.33	1.32	1.03	1.00	32	1.13	1.23	1.11	1.10	1.03	1.08
8	1.26	1.27	1.37	1.48	1.19	1.20	33	0.92	0.92	0.84	0.92	0.99	1.01
9	1.46	1.57	1.25	1.03	1.20	1.22	34	0.94	0.96	0.86	0.84	0.77	0.75
10	0.90	0.91	1.02	1.05	1.02	1.03	35	0.91	0.87	0.81	0.81	1.09	1.04
11	1.00	0.96	1.00	0.95	1.18	1.21	36	0.97	0.98	0.85	0.81	0.97	1.05
12	0.97	0.94	0.93	0.96	1.01	1.02	37	0.72	0.70	1.06	1.06	1.03	1.05
13	1.24	1.25	1.35	1.51	1.07	1.07	38	1.03	1.01	1.13	1.15	1.07	1.09
14	1.08	1.08	1.23	1.28	1.15	1.18	39	0.62	0.61	0.64	0.62	0.70	0.70
15	0.78	0.76	0.94	1.06	0.89	0.88	40	0.94	0.89	1.19	1.12	1.23	1.12
16	0.97	0.97	1.11	1.15	1.01	1.00	41	0.82	0.89	0.68	0.67	0.94	1.05
17	1.04	0.99	1.11	1.14	1.06	1.08	42	0.92	0.96	0.75	0.80	0.74	0.80
18	0.84	0.81	0.96	0.93	1.07	1.06	43	0.64	0.66	0.73	0.79	0.89	0.98
19	0.88	0.86	1.24	1.32	1.13	1.15	44	0.85	0.85	0.70	0.69	0.90	0.94
20	1.02	0.99	1.03	0.98	0.92	0.90	45	1.81	1.91	1.36	1.26	1.21	1.17
21	0.77	0.77	0.91	1.01	0.82	0.84	46	0.82	0.80	0.70	0.72	0.75	0.81
22	1.09	1.12	0.98	0.97	1.13	1.14	47	0.93	0.91	0.69	0.67	0.78	0.80
23	1.49	1.48	1.36	1.13	1.31	1.36	48	1.30	1.29	1.43	1.80	1.27	1.39
24	0.95	1.41	0.80	0.85	0.92	0.97	***Mean***	1.02	1.04	1.01	1.03	1.00	1.03
25	1.15	1.15	1.23	1.44	1.06	1.08	***SD***	0.24	0.27	0.22	0.24	0.14	0.14

Table 8. Fit Mean-square Statistics for CISS Task scale.

Year	1 (*n*= 104)		2 (*n* = 90)		Chronic (*n* = 205)	
Item	Infit	Outfit	Infit	Outfit	Infit	Outfit
1	1.05	1.06	1.63	1.69	1.39	1.45
2	1.29	1.39	1.12	1.61	1.05	1.04
6	2.03	1.92	1.31	1.21	1.12	1.04
10	1.08	1.12	1.10	1.25	1.29	1.30
15	0.90	0.94	1.11	1.06	1.26	1.30
21	0.93	1.05	0.97	0.88	0.92	1.25
24	1.00	1.24	0.89	0.84	0.93	0.87
26	0.74	0.73	0.90	0.86	0.94	1.10
27	1.01	0.89	0.81	0.91	0.93	0.93
36	1.07	0.99	1.01	1.03	0.96	0.96
39	0.73	0.71	0.80	0.78	0.89	0.88
41	0.84	0.79	0.78	0.75	0.85	0.80
42	0.98	0.99	0.89	0.80	0.74	0.69
43	0.68	0.77	0.82	0.81	0.89	0.86
46	1.47	1.52	1.29	1.23	1.13	1.33
47	0.80	0.73	0.91	0.91	0.89	0.80
Mean	1.04	1.05	1.02	1.04	1.01	1.04
SD	0.32	0.32	0.22	0.28	0.17	0.22

Table 9. Fit Mean-square Statistics for CISS Emotion scale.

Year	1 (*n* = 104)		2 (*n* = 90)		Chronic (*n* = 205)	
Item	Infit	Outfit	Infit	Outfit	Infit	Outfit
5	1.24	1.25	1.36	1.42	1.18	1.26
7	1.03	1.01	1.39	1.36	0.93	0.96
8	1.03	1.27	1.05	1.02	1.13	1.10
13	1.03	1.00	0.92	0.90	0.97	1.12
14	0.77	0.74	0.84	0.82	0.92	0.86
16	1.13	1.12	1.20	1.30	1.20	1.19
17	0.80	0.76	0.73	0.68	0.84	0.83
19	0.60	0.57	0.85	0.90	0.84	0.87
22	0.74	0.72	0.77	0.73	0.92	0.86
25	1.01	0.96	0.82	0.74	1.07	1.01
28	1.24	1.49	1.04	0.98	1.01	1.13
30	1.00	1.05	0.99	0.92	0.99	1.00
33	1.20	1.39	1.03	1.11	1.36	1.59
34	0.98	1.08	1.12	1.23	1.01	0.96
38	0.91	0.83	1.01	0.98	0.79	0.77
45	1.60	1.81	1.18	1.08	1.01	0.87
Mean	1.02	1.07	1.02	0.98	1.01	1.02
SD	0.23	0.31	0.19	1.08	0.15	0.20

Table 10. Fit Mean-square Statistics for CISS Avoidance scale.

Year	1 (*n*= 331)		2 (*n* = 331)		Chronic (*n* = 205)	
Item	Infit	Outfit	Infit	Outfit	Infit	Outfit
3	0.98	0.99	0.97	1.01	1.07	1.12
4	1.35	1.57	1.28	1.53	0.91	0.93
9	1.45	1.33	1.00	0.70	1.21	1.27
11	1.05	1.00	1.21	1.20	1.16	1.21
12	0.89	1.00	0.76	0.77	0.88	0.86
18	0.65	0.60	0.78	0.73	0.90	0.88
20	0.92	0.84	0.99	1.02	0.89	0.92
23	1.37	1.68	1.30	0.96	1.25	1.22
29	0.71	0.68	0.78	0.75	0.83	0.86
31	0.85	0.81	0.92	0.89	0.92	0.89
32	1.26	1.56	1.22	1.24	1.00	1.07
35	1.02	1.06	0.84	0.88	1.03	1.08
37	0.69	0.67	0.88	0.85	0.97	1.00
40	0.94	0.91	0.88	0.70	1.09	0.96
44	0.98	1.08	0.95	1.19	1.01	1.15
48	1.24	1.30	1.57	2.10	1.21	1.25
Mean	1.02	1.07	1.02	1.03	1.02	1.04
SD	0.24	0.32	0.22	0.36	0.13	0.14

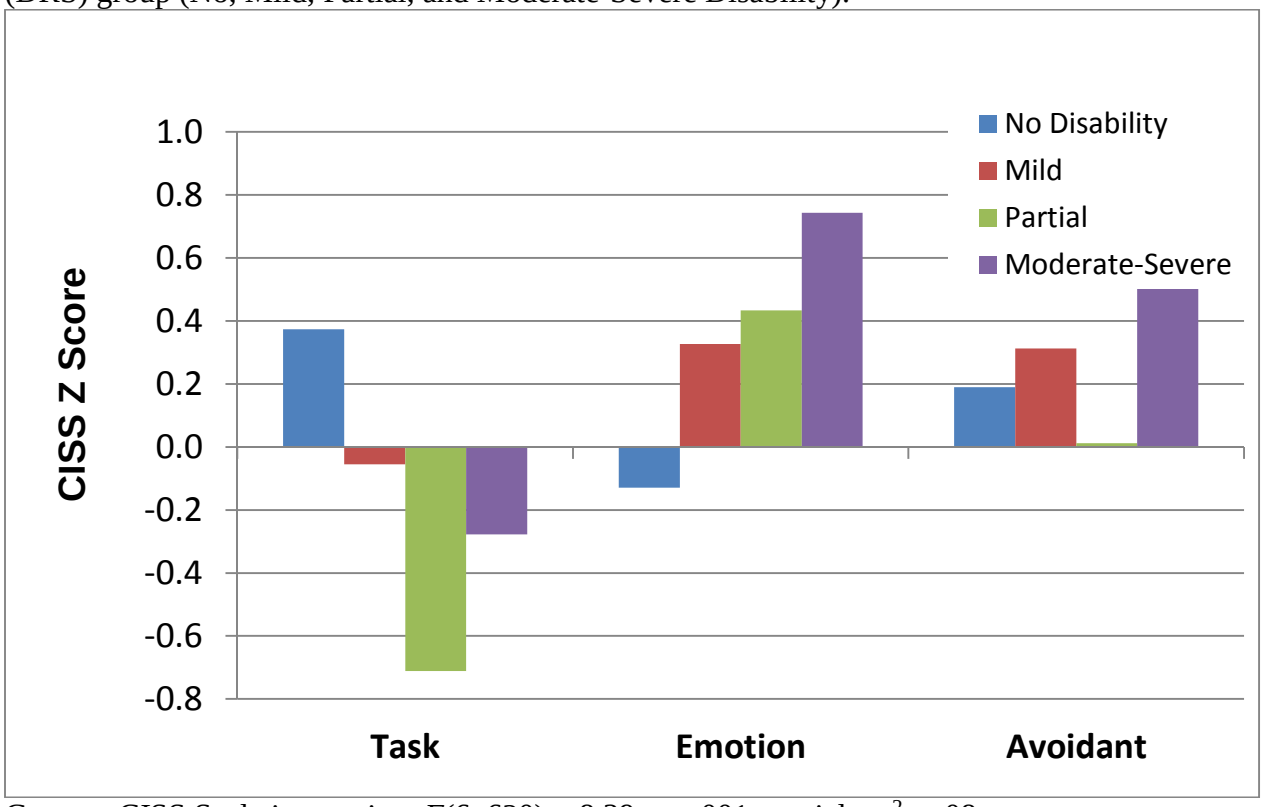
Table 11. Select diagnostic data for Rasch analysis with CISS.

Scale	Task			Emotion			Avoidance			All items		
Year	1	2	Chronic	1	2	Chronic	1	2	Chronic	1	2	Chronic
Person separation ratio	2.42	2.65	2.24	2.15	2.11	2.13	2.25	2.1	1.81	2.89	2.59	2.83
Person reliability	0.85	0.88	0.83	0.82	0.82	0.82	0.83	0.81	0.77	0.89	0.87	0.89
Item separation ratio	3.14	2.63	3.96	3.94	3.45	5.13	4.73	4.59	6.74	4.53	4.38	6.82
Item reliability	0.91	0.87	0.94	0.94	0.92	0.96	0.96	0.95	0.98	0.95	0.95	0.98
Raw variance explained by measures												
Empirical	43.2%	48.9%	41.3%	41.9%	39.0%	41.2%	43.4%	44.0%	37.6%	31.9%	32.3%	32.8%
Modeled	44.1%	49.9%	42.2%	42.4%	39.8%	41.8%	43.9%	44.8%	38.1%	32.4%	32.3%	32.9%
Unexplained variance in 1st contrast												
Raw	2.2	2	1.9	2.2	2.6	2.1	2.7	2.7	2.5	8.3	9.4	8.1
Percent	7.9%	6.3%	7.1%	7.9%	10.1%	7.8%	9.4%	9.3%	9.7%	11.8%	13.3%	11.3%

Note: Year 1 (n = 104), Year 2 (n = 90), Chronic (n= 205); all values reflect inclusion of all relevant items (no dropped items).

APPENDIX B

Figure 1. Coping Inventory for Stressful Situations (CISS) Scales by Disability Rating Scale (DRS) group (No, Mild, Partial, and Moderate-Severe Disability).



Group x CISS Scale interaction, $F(6, 620) = 8.39$, $p < .001$, partial $eta^2 = .08$.

Note. CISS Z score = raw scores converted using CISS manual normative data (Endler& Parker, 1999).

Figure 2. Item-Person Map: Chronic, All Items

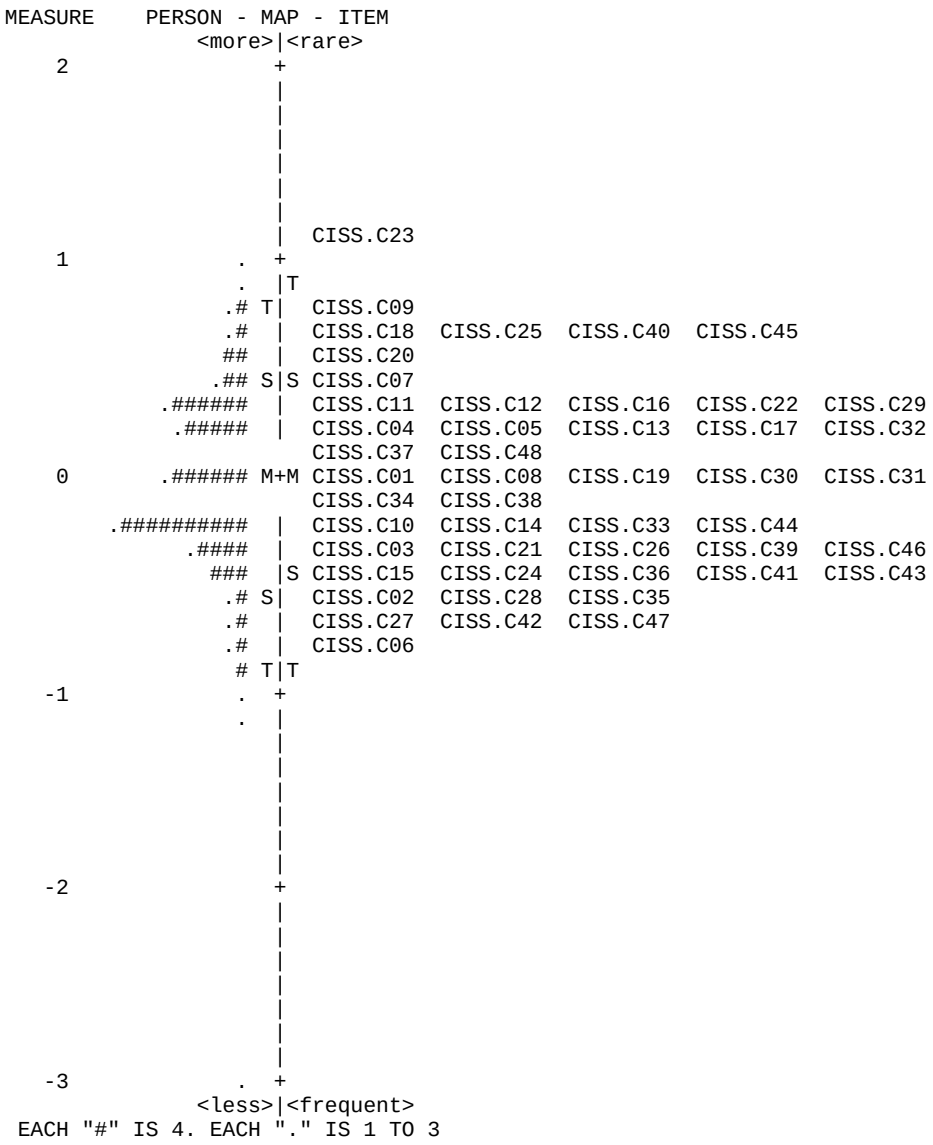


Figure 3. Response Category Thresholds: Chronic, All Items

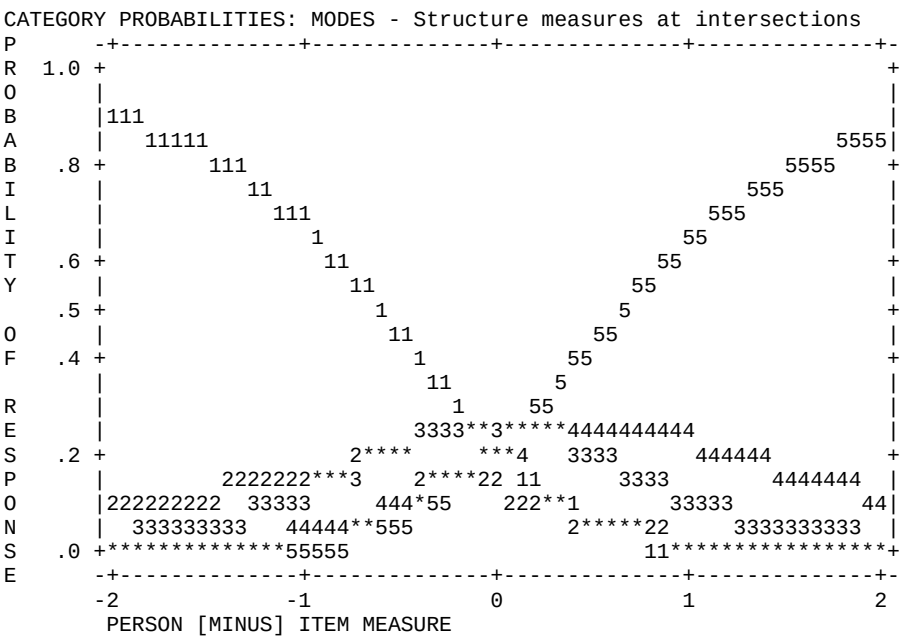


Figure 4. Item-Person Map: Chronic, Task

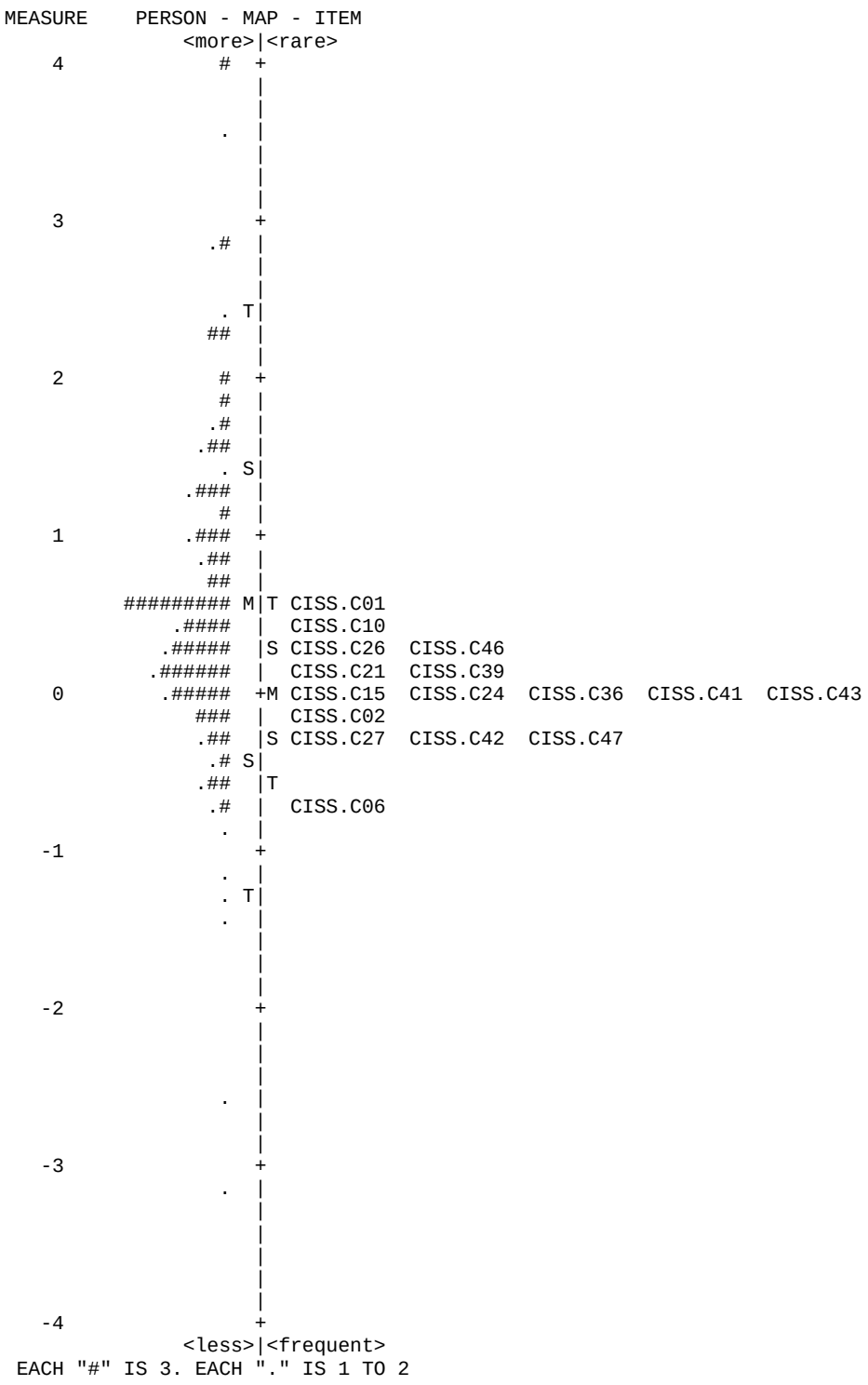


Figure 5. Item-Person Map: Chronic, Emotion

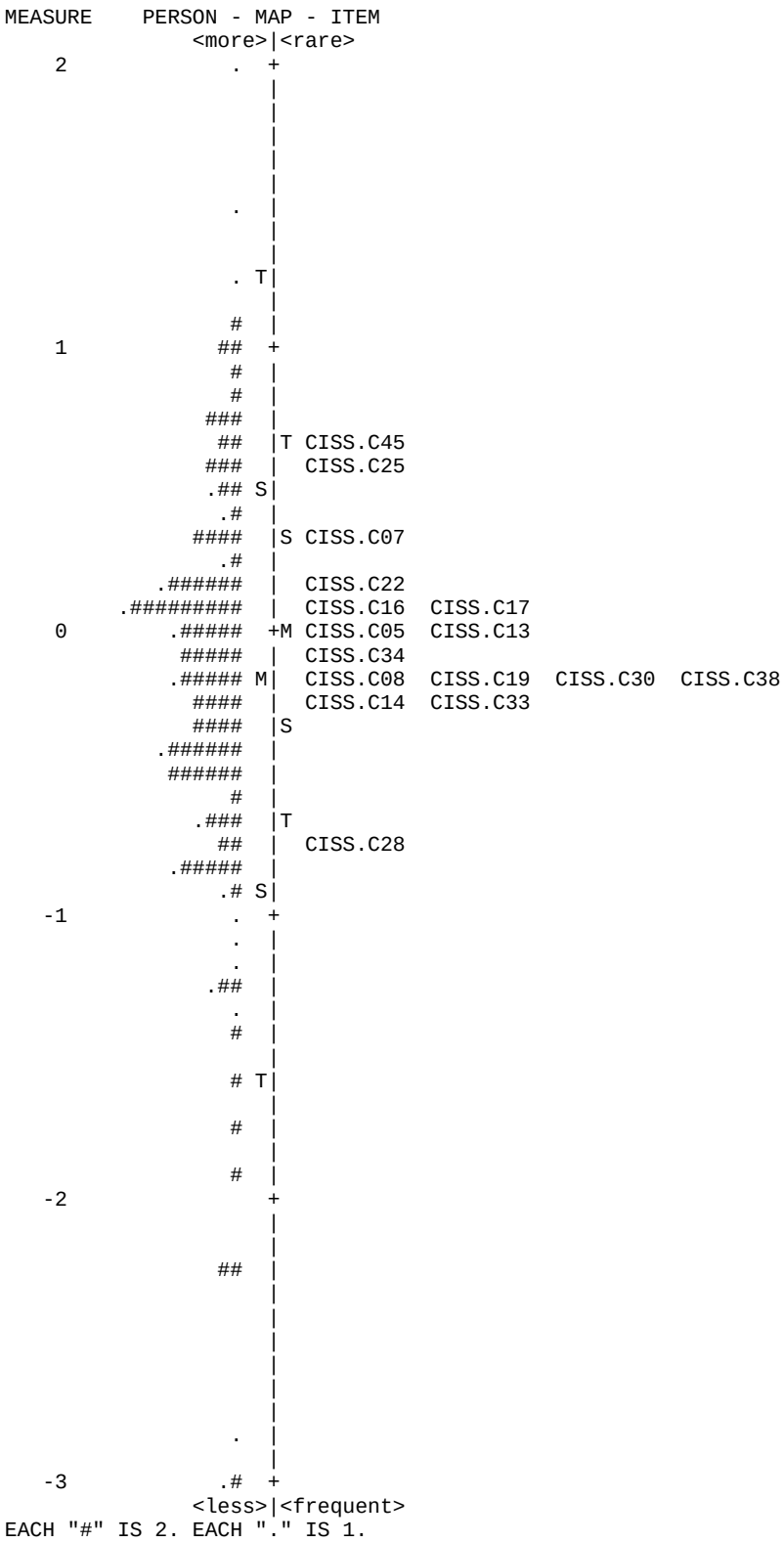


Figure 6. Item-Person Map: Chronic, Avoidance

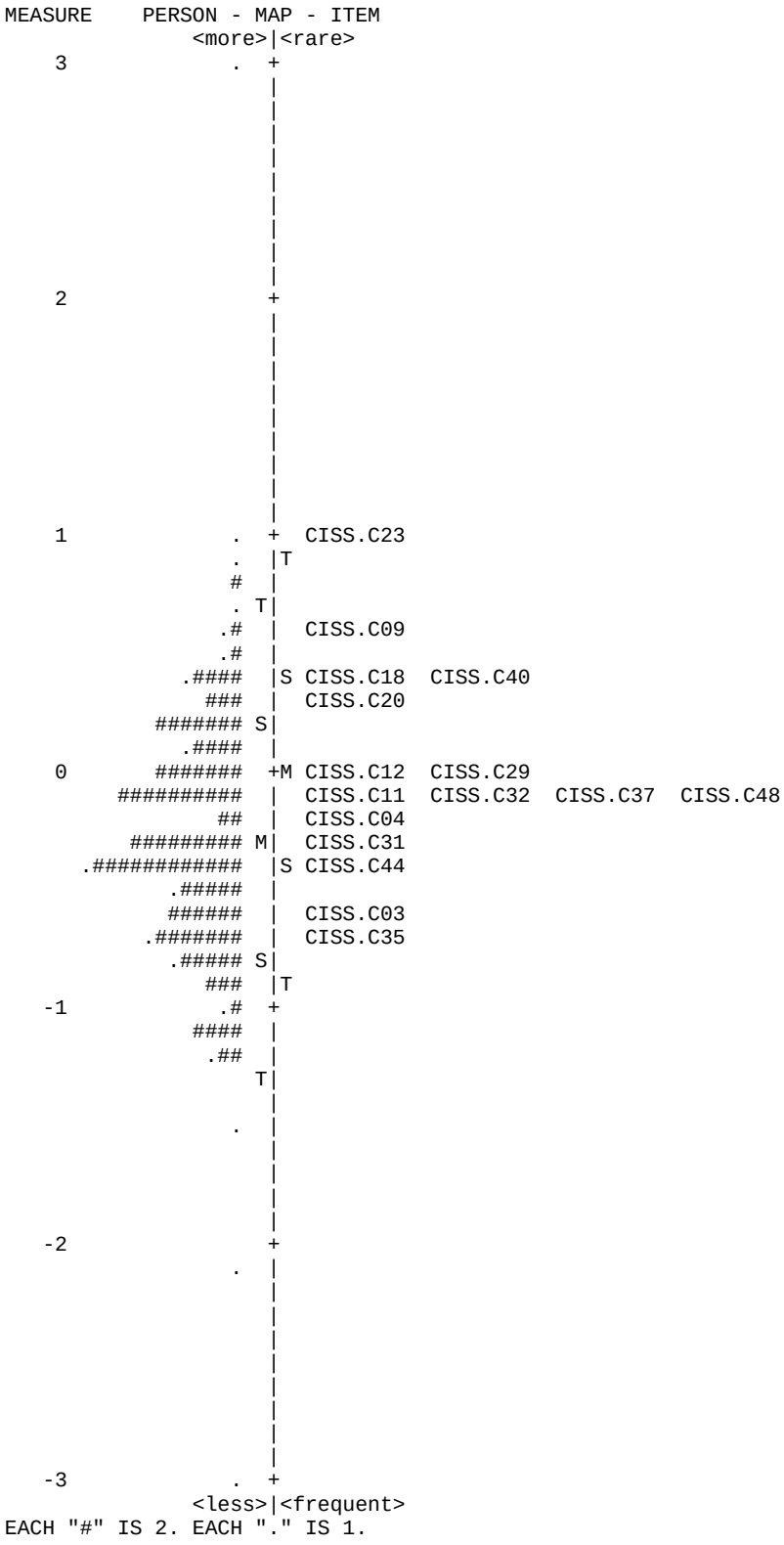


Figure 7. Item-Person Map: Year 1, All Items

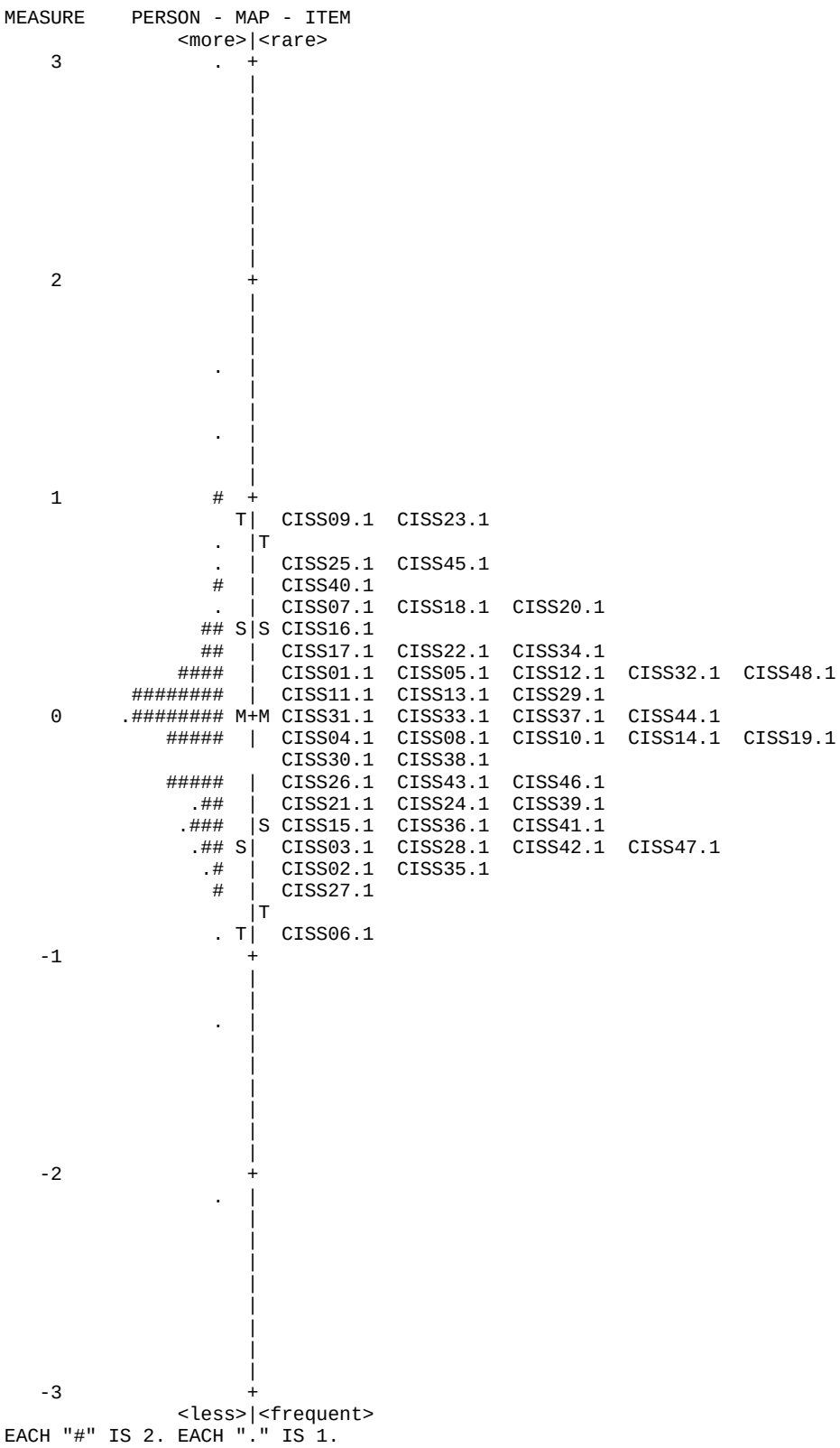


Figure 8. Item-Person Map: Year 1, Task

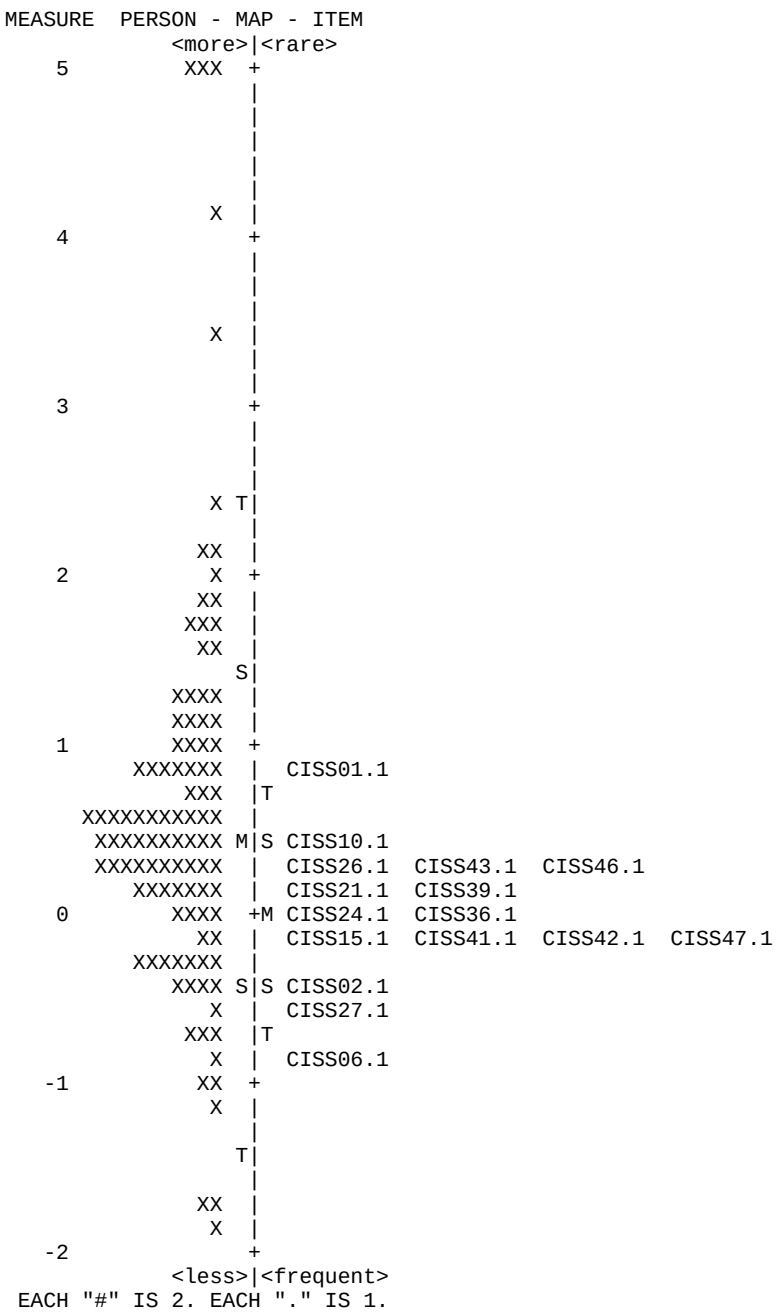


Figure 9. Item-Person Map: Year 1, Emotion

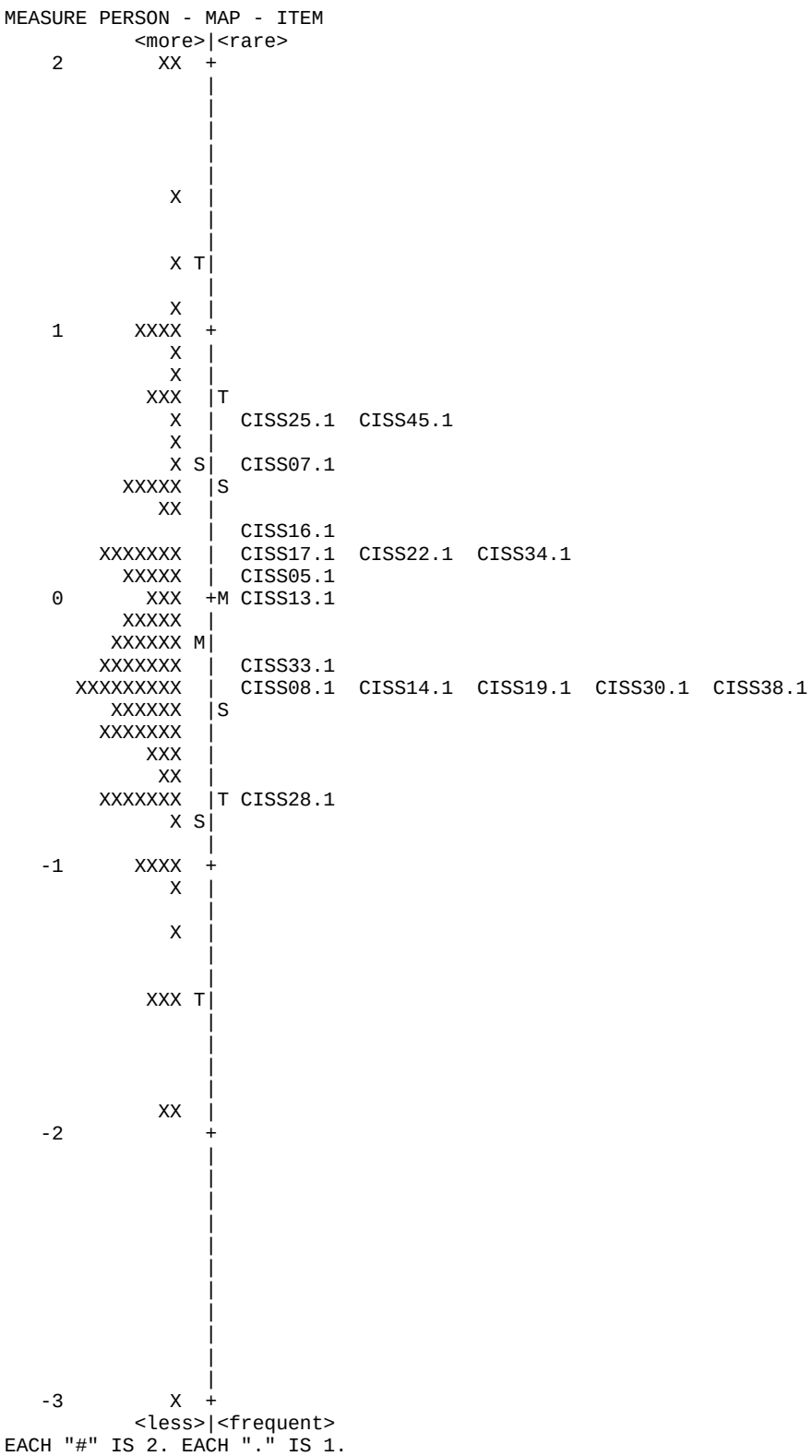


Figure 10. Item-Person Map: Year 1, Avoidance

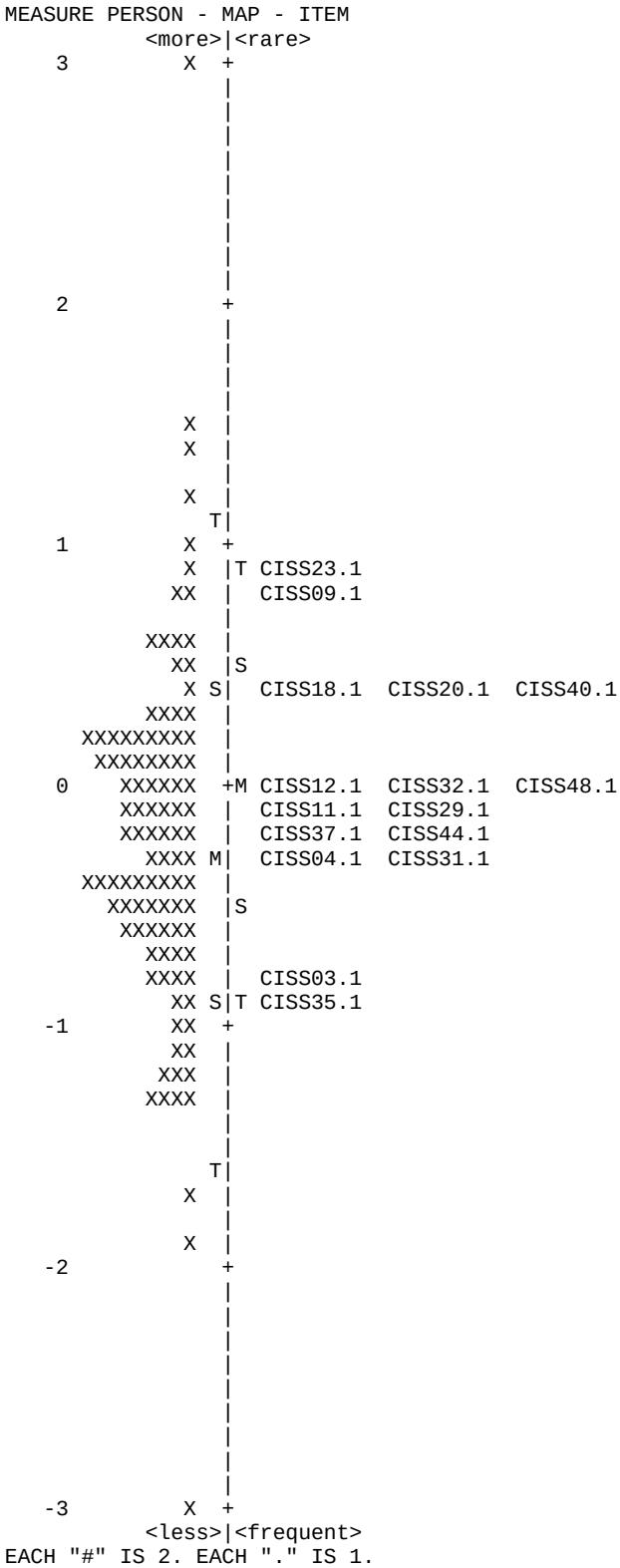


Figure 11. Item-Person Map: Year 2, All Items

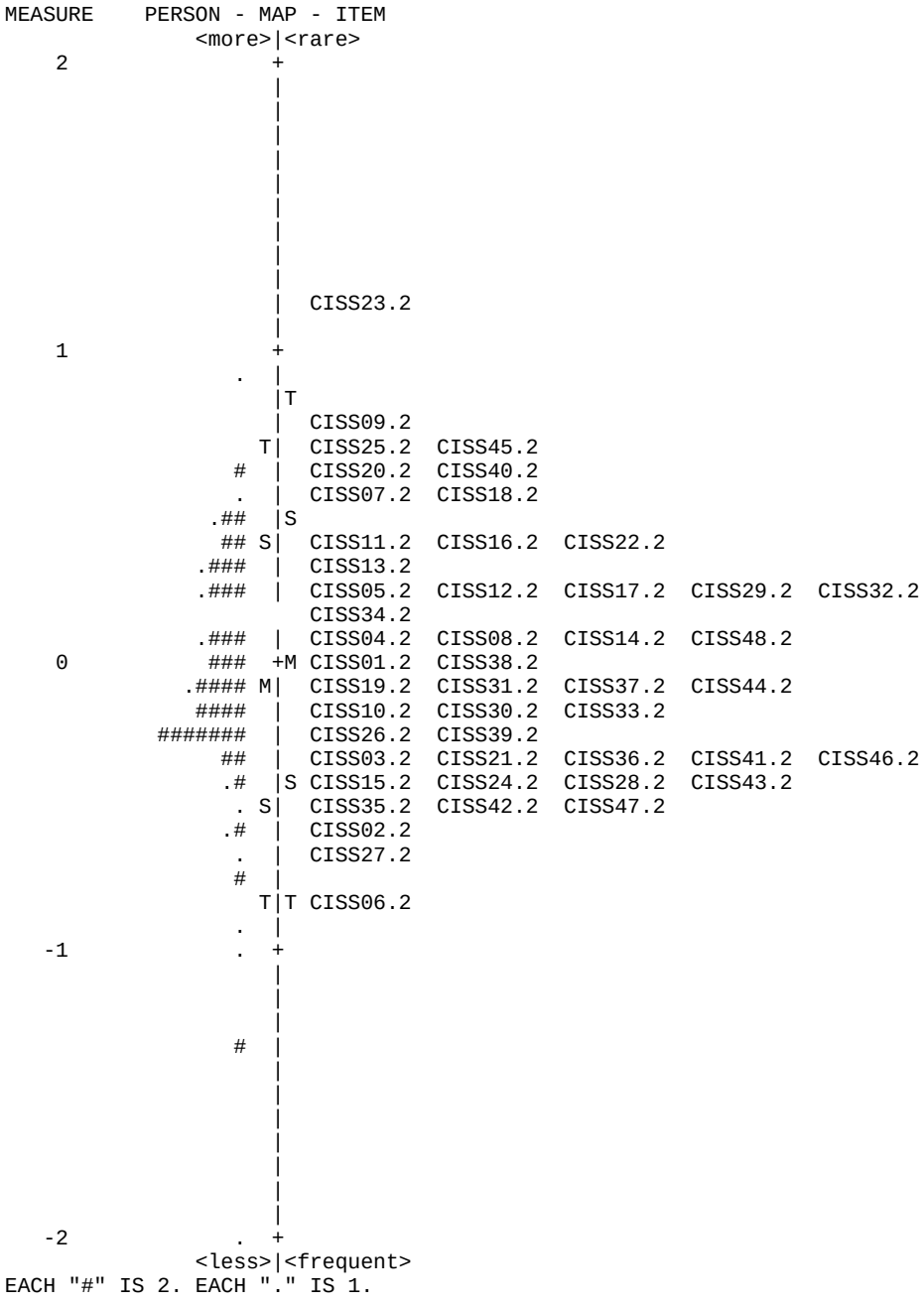


Figure 12. Item-Person Map: Year 2, Task

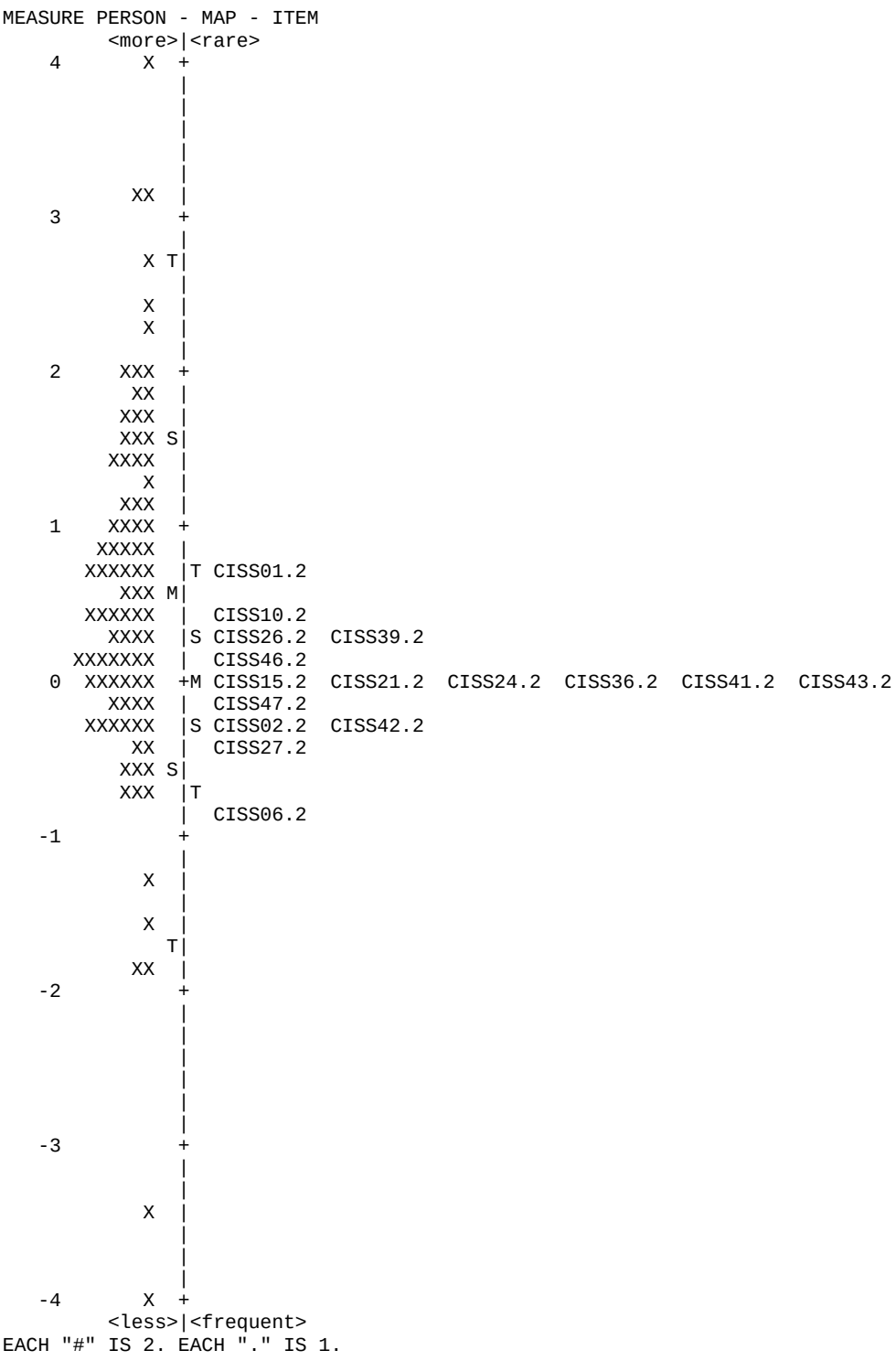


Figure 13. Item-Person Map: Year 2, Emotion

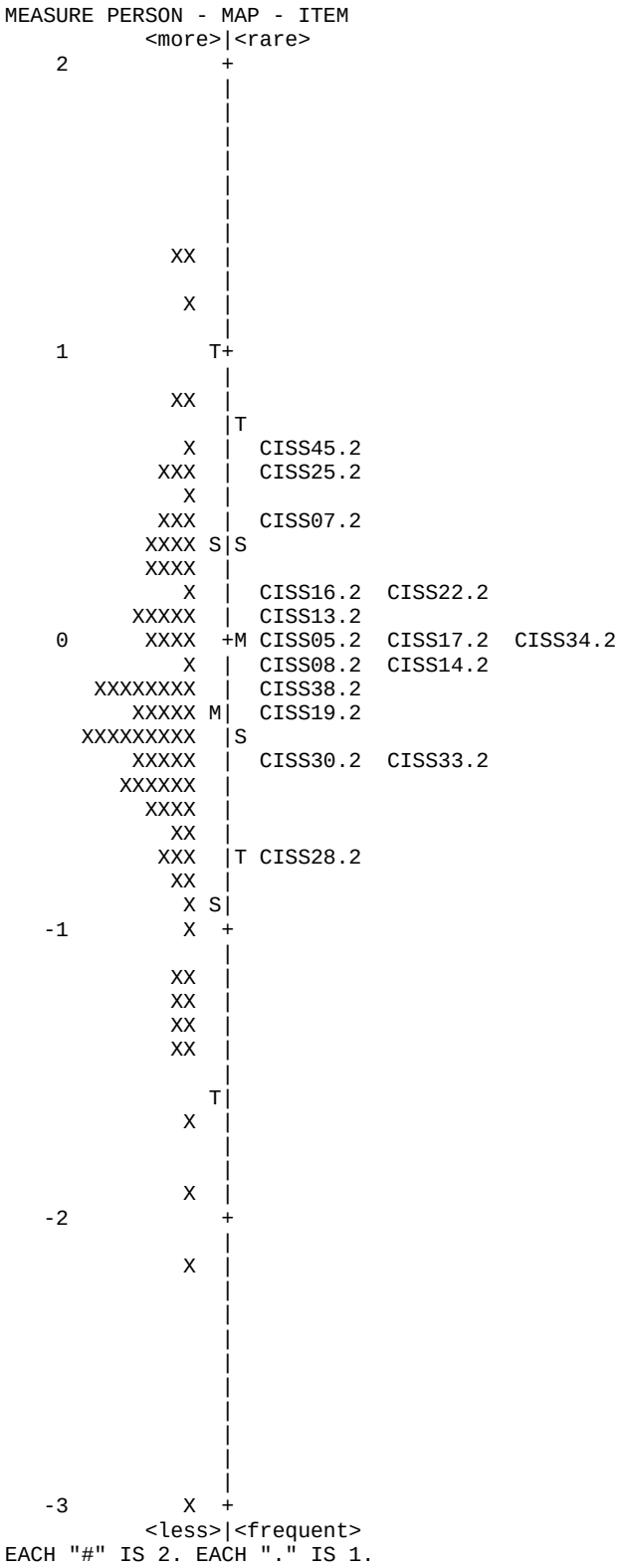
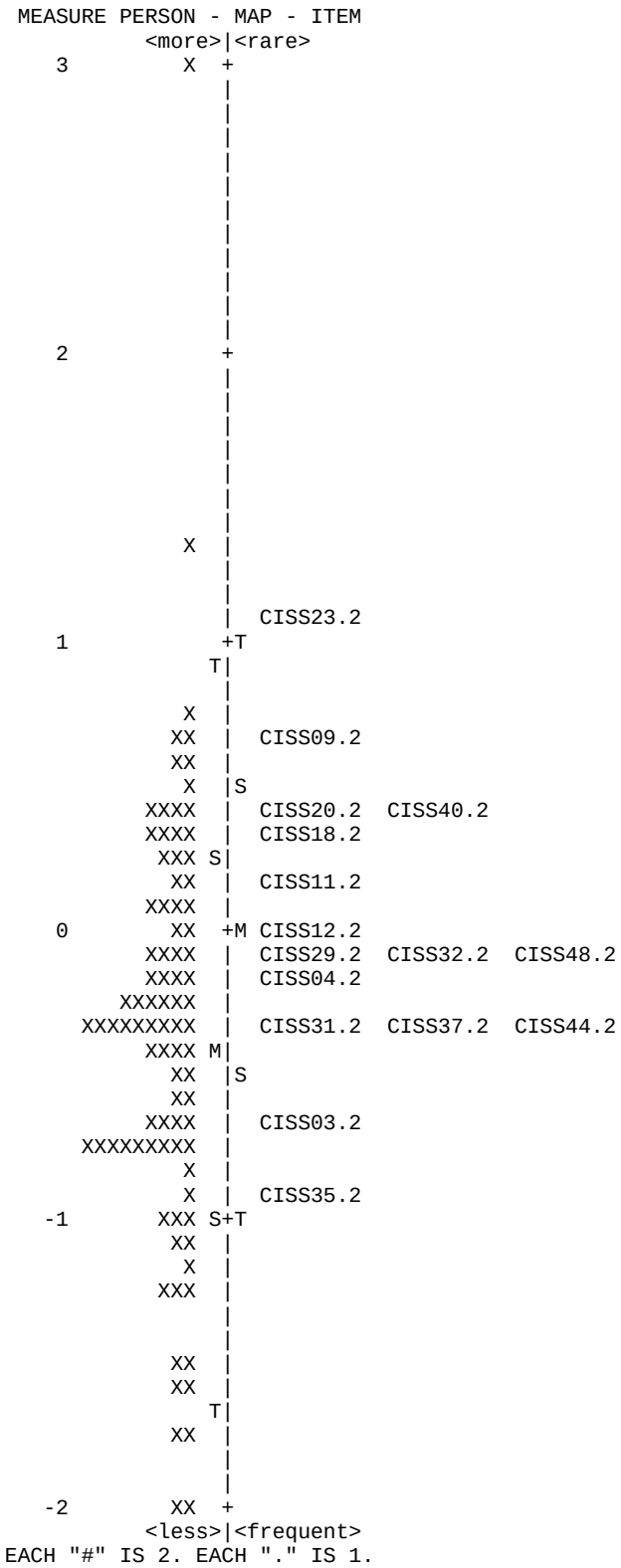


Figure 14. Item-Person Map: Year 2, Avoidance



APPENDIX C

WAYNE STATE UNIVERSITY

IRB Administration Office
87 East Canfield, Second Floor
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CONCURRENCE OF EXEMPTION

To: Hillary Greene
Psychology

From: Dr. Scott Millis
Chairperson, Behavioral Institutional Review Board (B3)

Date: May 21, 2012

RE:

IRB #:	056112B3X
Protocol Title:	The Psychometric Properties and Clinical Utility of the Coping Inventory for Stressful Situations (CISS) in Individuals with Traumatic Brain Injury (TBI)
Sponsor:	Psychology
Protocol #:	1205010925

The above-referenced protocol has been reviewed and found to qualify for **Exemption** according to paragraph #4 of the Department of Health and Human Services Code of Federal Regulations [45 CFR 46.101(b)].

- Protocol Summary Form (received in the IRB Office 05/07/2012)
- Protocol (received in the IRB Office 05/07/2012)
- A waiver of consent has been granted according to 45CFR 46 116(d) and justification provided by the Principal Investigator in the Protocol Summary Form. This waiver satisfies: 1) risk is no more than minimal, 2) the waiver does not adversely affect the rights and welfare of research participants, 3) the research could not be practicably carried out without the waiver, and (4)Providing participants additional pertinent information after participation is not appropriate.
- Data collection tools

This proposal has not been evaluated for scientific merit, except to weigh the risk to the human subjects in relation to the potential benefits.

- Exempt protocols do not require annual review by the IRB.
- All changes or amendments to the above-referenced protocol require review and approval by the IRB **BEFORE** implementation.
- Adverse Reactions/Unexpected Events (AR/UE) must be submitted on the appropriate form within the timeframe specified in the IRB Administration Office Policy (http://irb.wayne.edu/policies-human-research.php).

NOTE: Forms should be downloaded from the IRB Administration Office website http://irb.wayne.edu at each use.

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ABSTRACT

PSYCHOMETRIC PROPERTIES OF THE COPING INVENTORY FOR STRESSFUL SITUATIONS IN INDIVIDUALS WITH TRAUMATIC BRAIN INJURY

by

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Although research suggests that coping style affects recovery from traumatic brain injury (TBI), research on assessment of coping style after TBI is sparse. Prevalent theories in the general coping literature suggest a three-factor structure of coping style: task-, emotion-, and avoidance-oriented. However, this factor structure might not well characterize coping after TBI given the cognitive and emotional deficits associated with this population. Therefore, this study examined the psychometric properties of the Coping Inventory for Stressful Situations (CISS) among persons with moderate to severe TBI using approaches from Classical Test Theory (CTT) and Item Response Theory (IRT; Rasch analysis). This study also examined the relationship between coping style and TBI recovery, including subjective and objective well-being outcomes. Participants were 331 adults with moderate to severe TBI who were 1 to 15 years post injury. This was an archival study of a prospective data registry, examining cross-sectional assessments completed at 1, 2, 5, 10 and 15 years post injury. The primary measure of interest was the CISS. Outcomes included the Satisfaction with Life Scale (SWLS) and Disability Rating Scale (DRS). Predictors included demographic (age, education) and injury severity (Glasgow Coma Scale, DRS at discharge) characteristics, Positive (PA) and Negative (NA) Affectivity scales of the

Positive Affective and Negative Affect Schedule (PANAS), and the CISS (Task, Emotion, Distraction, and Social Diversion scales). Analyses from CTT and IRT approaches supported the reliability of the CISS among individuals with TBI across short- and long-term adjustment to injury and at various disability levels (median coefficient alpha = .89). Both approaches also supported the three-factor structure of the CISS in persons with TBI. Rasch analysis provided good psychometric support for the use of the CISS with TBI and identified areas for improved item discrimination. Hierarchical multiple regression analyses found that coping style uniquely predicted disability and life satisfaction at follow-up after accounting for sociodemographic factors, injury severity, and affectivity. These findings extend psychometric support for the CISS to the moderate to severe TBI population and highlight the clinical utility of assessing coping style with TBI for predicting functional and subjective well-being.

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